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JULY 1985 £1.10

CENTRONICS PRINTER BUFFER

PLUS

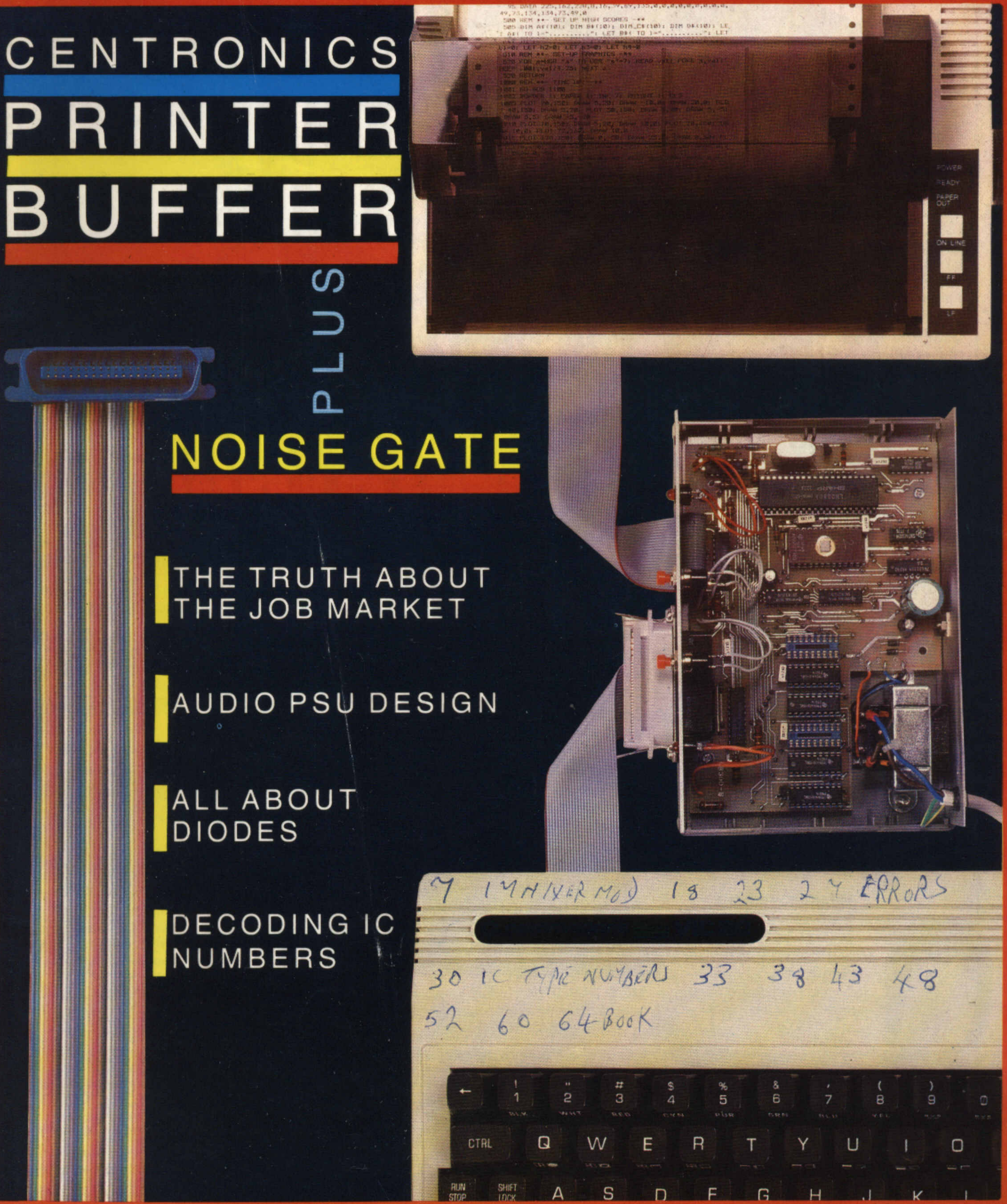
NOISE GATE

THE TRUTH ABOUT THE JOB MARKET

AUDIO PSU DESIGN

ALL ABOUT DIODES

DECODING IC NUMBERS



7 IMMIXER MOD 18 23 24 ERRORS

30 IC TYPE NUMBERS 33 38 43 48

52 60 64 BOOK

AUDIO....COMPUTING....MUSIC....RADIO....ROBOTICS..

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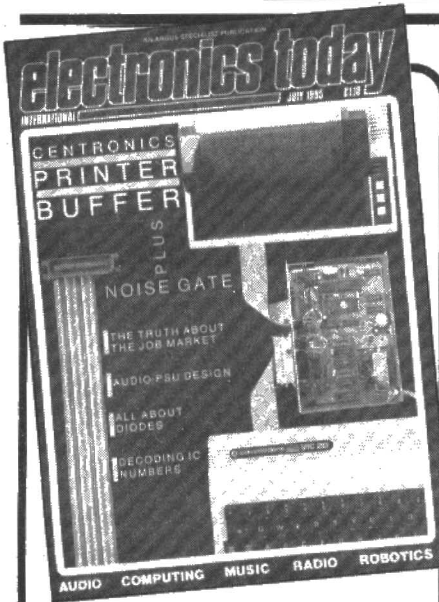
JULY 1985 VOL 14 NO 7



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– Electronics
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We regret that, once again, we have been unable to find room for the promised EPROM emulator article. We will do our best to make good the omission next month.

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DIGEST

TOBIE Award for EfP Co-ordinator

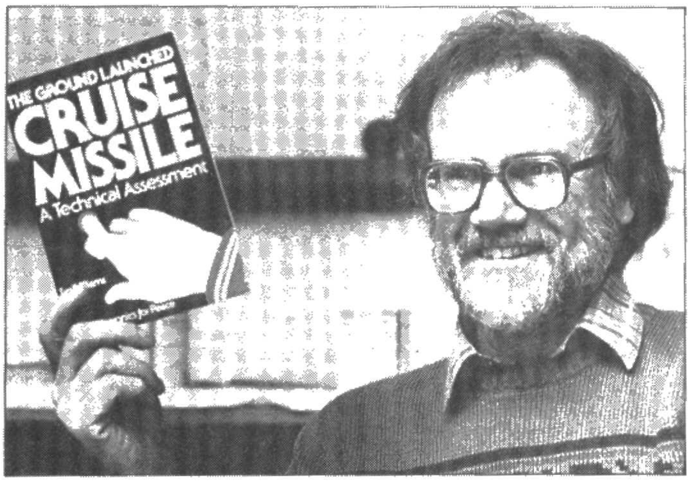


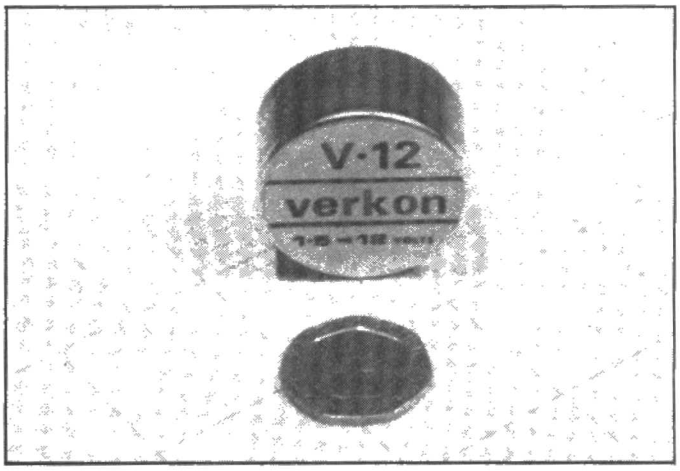
Photo courtesy of Electronics Times.

Tony Wilson, co-ordinator of the group Electronics for Peace, has won the 1985 TOBIE award for Electronics Personality of the Year.

Tony, who was interviewed in the April issue of ETI, was presented with the award at the All Electronics Week Ball held at the Grosvenor House Hotel in Park Lane. The presentation was made by Mick McClean, editor of Electronics Times.

There were three nominations for the award, one of seven given annually for Technology Or Business Innovation in Electronics. The other nominees were Sir Kenneth Corfield, chairman of STC and Tony Jannece and Alan Mansfield, directors of a small electronics company. The votes were placed by the readers of Electronics Times.

Of the other TOBIEs, the application award went to Louis Woolfson of Pathway Communications for his Braillewriter, a portable terminal which is unique in being able to produce hard copy in English from a braille input. Product of the year was the MG1 workstation from Whitechapel Computer Works and Greenwich Instruments won the Component of the Year award for their range of non-volatile memories. Deryck Horsham of Chelsea College won the Research Award for his high speed analogue to digital converter design.



U2 Can Save On Batteries

Biles Engineering are distributing a miniature, high efficiency, 1.5V DC to 12V DC converter with a maximum output current of 50mA. It is designed for use where 9-12V rails must be derived from a single 1.5V cell, and the manufacturers claim that it can offer a considerable saving in battery costs since 1.5V cells are almost invariably cheaper than higher voltage batteries of similar watt/hour capacities.

The Verkon V12 is a variable-drive switch-mode step-up converter which is encapsulated in epoxy resin and sealed in a seamless steel case. A high degree of screening results and the device is also rugged enough to be used in portable equipment where shocks and vibrations can be expected. No heatsinking is required and it can be directly mounted on a PCB or chassis mounted using a 30mm capacitor clip.

In use it must be connected to a capacitor of 470uF minimum mounted as close to the pins as possible, and a decoupling capacitor on the input may be required depending on the distance from the cell to the pins. The V12 can withstand a momentary short circuit but should be protected against long term short circuits. A fuse of 100mA or less is recommended between the output capacitor and the load.

The V12 could be used to supply equipment directly at 12V from a 1.5V cell or the output voltage dropped through a regulator to the more commonly used 9V. In this case, the supply to the equipment would probably be more stable than if it were taken directly from a 9V battery. In either case, the use of a V12 and a 1.5V 'D' cell should work out cheaper than using 9V batteries.

The manufacturers point out that an alkaline 'D' cell costs only about half as much as the alkaline PP3 but has three times the watt/hour capacity. Given the V12's 80% conversion efficiency, even with a 25% voltage drop in a regulator the life of the 'D' cell will still be around twice that of a PP3, with consequent savings in cost.

The V12 costs £5.25 including VAT plus £0.45 post and packing. It is available from J. Biles Engineering, 120 Castle Lane, Solihull, West Midlands B92 8RN, tel 05432 -22382.

Epson Introduces New Printers

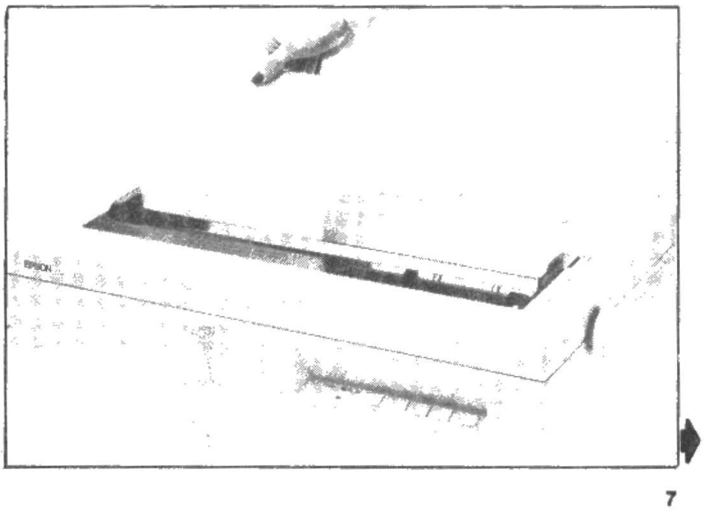
Epson have launched the first two models in a range of ink-jet printers which, they claim, offer the speed of dot matrix machines and quality comparable with that of daisy wheels but without the noisiness of either.

They say they have avoided the problems usually associated with ink-jet printers by using a specially formulated ink, a cap which automatically seals the printing head when the machine is not in use, and an instant head cleaning system available at the touch of a button.

The SQ-2000 is at the top of the range and offers 105 CPS in letter-quality mode and 176 CPS in draft mode. The head uses 24 nozzles and a wide range of typefaces are included. Further typefaces and a range of slot-in interface boards can be added.

The HS-80 is a brief-case sized A4 printer which has a nine nozzle head and offers 160 CPS (not including line throws). It should be available in the Autumn.

Epson (UK) Ltd, Dorland House, 338 High Road, Wembley, Middlesex HA9 6UH, tel 01 - 902 8892.



- Texas instruments have published two new semiconductor brochures, one dealing with linear and interface circuits and the other with industry standard line circuits. The first brochure covers the complete spectrum of TI analogue and interface circuits and includes an alpha-numeric listing and equivalents table, while the second describes international standards such as RS232, RS423, IEE488, etc. The brochures are available on request from Texas Instruments Ltd, Manton Lane, Bedford MK 41 7PA, tel 0234 - 63211.

- **Carston Electronics are offering the DEC Rainbow and several other personal computers at a greatly reduced price for a limited period. The Rainbow costs £1350 for the 64K version or £1750 for the 128K version, the Decmate 2 costs £2350 and the Professional 350 costs £3200, all exclusive of VAT. Carston Electronics Ltd, 99 Waldgrave Road, Teddington, Middlesex TW11 8LL, tel 01 - 943 4477.**

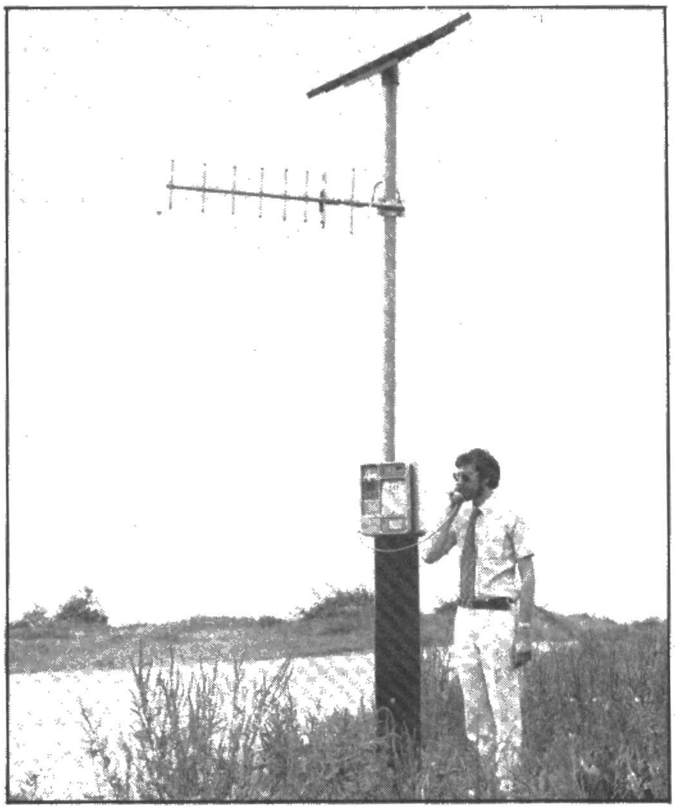
- *The Amateur Computing Club have sent us a copy of the latest issue of their journal, ACCumulator. It contains articles on the C language and robotics amongst others and those interested in joining and receiving ACCumulator should contact Andy Leeder, Church Farm, Stratton St. Micheal, Norwich.*

Rural Radio Payphone

Plessey Radio System has developed a stand alone, rural payphone system which could put the Third World on the telephone. The roadside telephone needs no conventional wires for communications because it is powered by solar or combined solar and wind energy and uses radio to link up with the exchange.

Solar or wind power, or a combination of both, charge an inbuilt battery system which in turn powers the radio and payphone. The payphone, which is of the type extensively used by British Telecom in the UK, is equipped with ringing facilities, tariff signalling and a liquid crystal readout of coin values. It is housed in a vandal proof case.

In operation, speech is carried through an integral transmitter to the nearest exchange or junction to gain access to the country's trunk network, enabling the caller to have full national or international telephone facilities. The payphone is also able to act as a direct local link, on a point to point basis, so that remote villages can communicate with each other. The radio is available on 450MHz and 1.5GHz.



The payphone is able to recognise 24 different currencies and an inbuilt cash management system reports when the coin box is 75 per cent full. For simple installation a metal plate at the foot of the payphone pole is dropped into a concrete base.

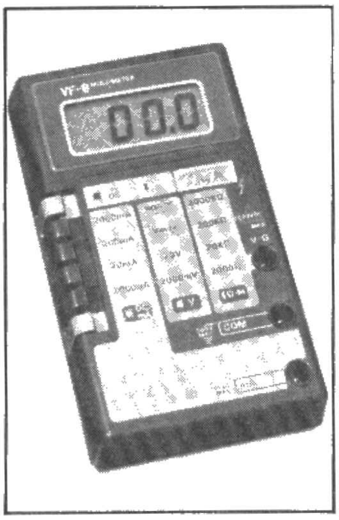
An adaption of the payphone configuration has already been installed in Turkey where a completely mobile post office with full service facilities is bringing a new communications technology to villages and seaside resorts. Early discussions are now taking place with a South American country.

Well Protected DMM

Harris Electronics are marketing the TMK VF9 multimeter, a pocket-sized, push-button digital multimeter with a 3½ digit LCD display. It has a basic DC accuracy of 0.5%, automatic over-range and low battery indication and the manufacturers claim that it has been designed throughout with safety in mind.

The VF9 will measure up to 100V DC and 750V AC with a minimum resolution of 1mV. The four resistance ranges cover 1R to 20M and the DC current ranges allow measurements from 1uA to 2A. A 2amp fuse forms part of the overload protection system and all inputs are fully protected on all ranges, including resistance.

The LCD display has ½" high digits and includes polarity indication. The low battery warning appears when about 10% of the battery life remains, and Harris claim that a life of about 2000 hours can be expected with alkaline cells. The input jack sockets and the test leads comply with UL 1244 and VDE 0411 safety requirements.



The VF9 measures 130 x 75 x 28mm and weighs 195g. It is guaranteed for twelve months and costs £34.95 plus VAT complete with battery, manual and test leads. Harris Electronics (London), 138 Grays Inn Road, London WC1X 8AX, tel 01-837 7937.

Active Loudspeaker Stands

Taking a novel approach to the problem of getting more bass from small loudspeakers, Asscom have come up with a hollow stand which couples to a 'speaker to increase its effective volume. The stands come in kit form and are designed for the Wharfdale Diamond, but the manufacturers say they can easily be adapted to suit other small loudspeakers.

The stands are made of wood and incorporate a tapered column which is tuned to boost low frequencies. The loudspeaker attaches to the front of the stand and acoustic coupling is achieved by means of a hole in the front face of the stand and the hole in the back of the loudspeaker which normally carries the connector panel. In the case of the Wharfdale Diamond, this hole is about 3" in diameter. Once the panel has been removed, the loudspeaker can be screwed to the stand using the connector plate fixing positions and the wiring extended to a new connector plate position on the back of the stand.

Asscom claim that the active stands extend the response of the Diamonds downwards by about 30Hz and do so without affecting the upper base and midrange. They say that the effect is to add weight to the sound without introducing any of the artificial boominess often associated with cheap loudspeakers which attempt to imitate an extended bass response by emphasising the upper bass region.

The kits include pre-cut panels, battens, screws, pins, wadding, damping, woodgrain-effect vinyl covering material, etc. Asscom will consider producing a ready-built version if the demand warrants it. The kit costs £29.95 per pair plus £4.95 post and packing, and an instruction manual containing the plans and details of some other modifications is available for £4.95.

Asscom, Unit 8, Mossedge Industrial Estate, Linwood, Renfrewshire PA3 3HR, tel 0505 - 35974.

Containerised TV Station

Incomtel have developed a powerful television transmitter station which is totally self sufficient within multiple 20' long steel containers and can begin broadcasting within days of arriving on site, anywhere from a remote jungle clearing to an isolated desert range.

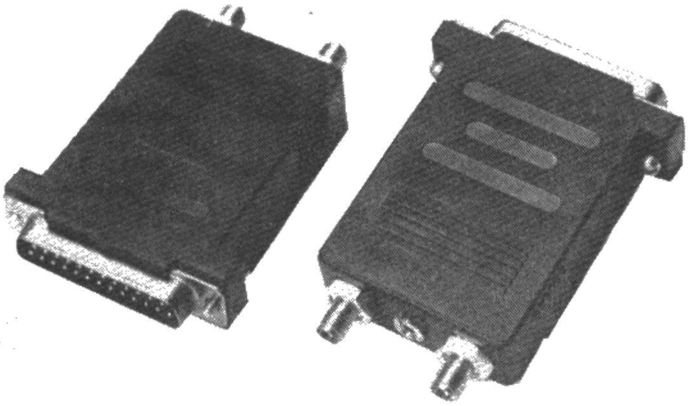
Incomtel claim that this is the fastest way to introduce a TV service to a region, and the savings for the customer will be in time and money since no permanent buildings will be needed and relocation is fast and simple. Other customers, with established TV networks, have also shown interest in a containerised station to back their permanent installation, ensuring broadcasting continuity around the clock in the event of an emergency or breakdown. The only civil engineering works required are mast foundations and concrete bases for the main containers and the diesel generating set.

In this first station three of the containers have been designed to accommodate two 10kW Band III TV transmitters, together with two high voltage power transformers, two programme input racks and test equipment. The UHF link receiver rack, notch diplexer, aural and visual dummy loads with changeover switches together with the pressurisation system for the antenna coaxial cable and UHF waveguide are all installed within the three container 'heart' of complex.

Each of the steel fully insulated ribbed ISO containers are air conditioned and special precautions have been taken to inhibit the ingress of fine dust and sand. A specially designed sun roof canopy will protect the entire complex in countries with extreme temperature conditions and each station will be totally independant with its own water, power and fuel supplies.

A custom-designed Rolls Royce 125kW generating set complete with bulk fuel tank fits into a single container which has been sound-proofed to a high standard. Also provided within the complex are reception, staff accommodation and recreation areas, office and stores. To complete the pakage there is a 150 metre mast fitted with a 12 panel double dipole Band III directional antenna system and a 13 GHz parabolic link antenna.

Incomtel Ltd, 225 Goldhawk Road, London W12 8SB, tel 01 - 743 5511.



RS232C Optical Fibre Link

Belling Lee Intec have introduced a full duplex optical fibre transceiver which plugs directly into the standard 'D' type connector used for RS232C interfaces. They claim that it allows high performance transmission of data over an extended distance without the need for data cables.

The L2840 can be used with fibre optic cables of 100 microns and upwards and is fitted with 9mm SMA-style fibre optic connectors. Data rates from DC to 64k baud can be accommodated and a special feature is the ability to be configured internally as either a data terminal equipment (DTE) or data communications equipment (DCE). The supply voltage is 9V connected via a miniature jack plug from an external mains adaptor.

A data sheet describing the L2840 is available from the manufacturers, Belling Lee Intec Ltd, 540 Great Cambridge Road Enfield, Middlesex EN1 3QW, tel 01 - 367 0080.

● We have received a lot of requests for cut-price back-numbers following our offer in these pages last month. We have sold out of many of the issues listed but still have copies of November 1982, January 1983, May 1983 and December 1983 going for 50p each. If you want a copy of any of these issues, just send us a cheque or postal order for the appropriate amount and, to save us time, enclose your name and address on a gummed label or at least on a piece of plain paper which we can paste down.

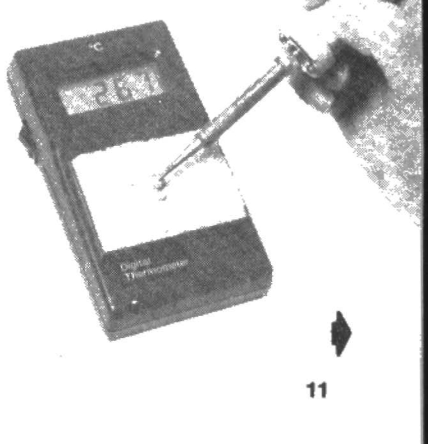
Soldering Iron Thermometer

Designed for use in applications where soldering iron tip temperature must be precisely controlled, West Sussex Instruments have introduced a digital electronic thermometer which will provide readings of tip temperature in seconds.

The WSI 500 has an integral sensor mounted on the front panel and will measure temperatures from -50°C to +500°C. It has a resolution of 1°C and an accuracy of 0.5% ± 1 digit plus the deviation of the thermocouple. The liquid crystal display has 12.5mm high digits and the meter will operate for approximately 1000 hours from a PP3 alkaline battery.

In operation, the soldering iron is simply pressed against the sensor and a reading is obtained within seconds. An area of sponge surrounds the sensor so that the bit can easily be cleaned.

The WSI 500 costs £39.50 plus carriage and VAT and is available from West Sussex Instruments Ltd, 12A Coronation Buildings, Brougham Road, Worthing, West Sussex BN11 2NW, tel 0903 - 212303.



Events Diary

Unix Training Course - June 11-12th
Plessey Microsystems Training Centre, Towcester. Training in Unix system 111 or V, including hands-on experience using a Plessey System 68. Aimed at data managers and software staff interested in multi-user computer techniques. Contact Plessey Microsystems, Sales Office, Water Lane, Towcester, Northamptonshire NN12 7JN, tel 0327 - 50312.

Computer Graphics Course - June 11-14th
Cafe Royal, Regent Street, London. A comprehensive overview which moves from fundamental concepts to the selection and effective use of top-flight workstations and software. The cost is £585.00 plus VAT and details are available from ICS at the address below.

European Unix User Show - June 12-14th
Olympia 2, London. For details see June issue or 'phone 01 - 837 3699.

Computers In Manufacturing Show - June 24-27th
Olympia 2, London. For details see June issue or 'phone 01 - 891 3426.

Networks - June 25-27th
Wembley Conference Centre, Wembley, Middlesex. Exhibition and conference covering Local Area Networks, electronic mail and other data exchange networks. The full conference programme costs £395.00 + VAT, exhibition entrance costs £5.00 and the organisers expect about eighty exhibitors. Contact Online at the address below.

Condition Monitoring In Hostile Environments - June 26th
Regent Crest Hotel, London. For details see June issue or 'phone 0372 - 374151.

Living With Quality Demands BS5750 - June 27th
PERA, Melton Mowbray. One day seminar organised by the Production Engineering Research Association and designed to help production and quality control staff understand and implement the requirements of BS5750. Cost is £125 + VAT with a discount for PERA members. PERA, Melton Mowbray, Leicestershire LE13 0PB, tel 0664 - 501329.

Personal Robotics Conference & Exhibition - July 2-4th
West Centre Hotel, London. Sponsored by a number of bodies including the IEE, the event includes a conference attended by speakers from the USA and Europe, specialist workshops and the UK finals of the Micromouse competition. The cost is £250.00 + VAT which includes all refreshments, etc. Oyez Scientific & Technical Services Ltd, Third Floor, Bath House, 56 Holborn Viaduct, London EC1A 2EX, tel 01 - 236 4080.

Programming In C: A Hands-On Workshop - July 2-5th
Cafe Royal, Regent Street, London. Each participant is given access to a Unix system with a C compiler and instructed in the writing and execution of C programmes. The cost is £635.00 + VAT and details are available from ICS at the address below.

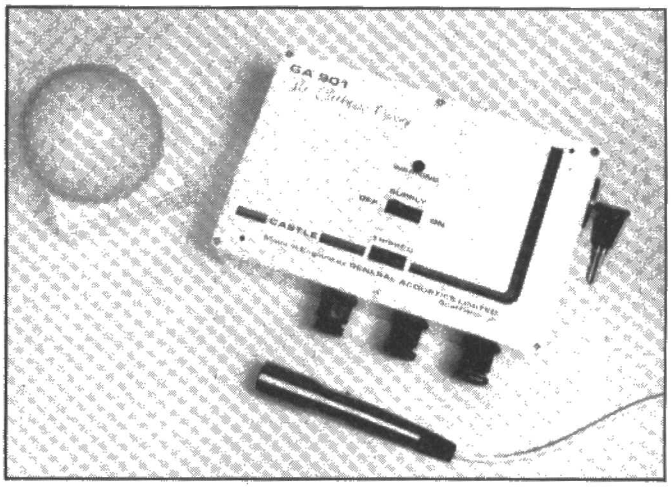
Leeds Electronics Show - July 3-5th
University of Leeds. See June issue for details or 'phone 0799 - 26699.

Cable - July 9-11th
Metropole Hotel, Brighton. Conference and exhibition expected to attract 60-70 exhibitors. Conference topics include technology now and in the future, teleshopping and other interactive services and the question of subsidy versus investment. Exhibition entrance costs £10.00, full conference programme costs £330.00 + VAT and details are available from Online at the address below.

Personal Computer World Show - September 4-8th
Olympia, London. The main exhibition covers home and educational computing while a separate exhibition in Olympia 2 caters for business and professional users. For details contact Montbuild Ltd, 11 Manchester Square, London W1M 5AB, tel 01 - 486 1951.

Addresses:

ICS Publishing Company (UK) Ltd, 3 Swan Court, Leatherhead, Surrey KT22 8AD, tel 0372 379211.
Online International Ltd, Pinner Green House, Ash Hill Drive, Pinner, Middlesex HA5 2AE, tel 01 - 868 4466.



Fresh Orange

Castle Associates have introduced the latest version of their 'Electronic Orange', a noise monitoring system intended for use in places of entertainment. The new model has been designed specifically for use in dicotheques and removes the mains supply to the sound console if the noise level exceeds the threshold and the DJ ignores warnings to reduce the volume.

The Mk1V Electronic Orange consists of a microphone, a control unit and the distinctive orange warning lamp. The microphone should be mounted in the main dance area and its output is fed to the control unit. A sound level circuit built to the requirements of BS 5969 Type 2 compares the incoming signal with a preset level and illuminates the warning lamp if it is excessively high. If the DJ does not respond to the warning by reducing the sound level, the unit will allow a short delay and then briefly interrupt the supply to the disco console. This short period of silence provides an effective deterent and ensures that the volume is generally maintained at a reasonable level.

Castle Associates point out that complaints about high noise levels from places of entertainment feature regularly in the Environmental Officer's league table of complaints and that the recent Local Government (Miscellaneous Provisions) Act 1982 gives Local Authorities the power to prescribe conditions and restrictions before licensing a place of entertainment. The complete Electronic Orange system costs £350.00 plus VAT and comes with comprehensive installation instructions.

Castle Associates Ltd, Slater Road, Cayton Low Road Industrial Estate, Scarborough, North Yorkshire YO11 3UZ, tel 0723 - 584250.

BBC Headphone Protector

The BBC's Engineering Designs Department has developed a compact limiter which protects headphone listeners against excessively high sound levels. The device introduces no distortion until the limiting level is reached, draws its power from the signal so that no other power source is required, and the design is now available to UK firms to manufacture under licence.

The protector is smaller than a matchbox and is wired into the lead between the amplifier and the headphones. The limiting level is set during assembly to a value in the range 95 to110 dBA and an averaging network prevents the limiter operating on short duration peaks. To allow for the dynamic range of the signal, the operation of the averaging circuit is such that the mean programme level must be about 5 to 8 dB below the limiting level if it is not to be clipped. A weighting network is included to prevent the limiter acting on the less harmful low frequencies.

The BBC say that some form of protection is essential where headphones could inadvertently be connected to the loudspeaker output of an amplifier, and that there is also a need because listeners often use headphones at high volume levels, especially where there is ambient noise.

The Engineering Information Department, BBC, Broadcasting House, London W1A 1AA, tel 01 - 927 5432.

ETI

READ/WRITE

Logical Captain

Dear Sir,

I thought technical people were logical thinkers — but I'm afraid the letter from Mr. Wakeham (ETI, May 1985) didn't appear too well hung together to me. Judging from the Editor's little piece, it would appear he thought it was a bit up in orbit too . . .

Of course, the usual paranoia about 'communism' was seen. Yet there are a large number of 'communist' philosophies — Christian communism, Libertarian communism (I'm sympathetic to that), etc. I suspect Mr. Wakeham means the corrupt old business said to be based on a few things that a certain Karl Marx went on about. Then we read all about being phone-tapped — with bated breath! (By our democratic State! — Britain — land of the free — shame on you Mr. Wakeham . . .) Yet we read a 'curse on both your houses' — Communism and Capitalism.

I wonder if Mr. Wakeham realises that FREEDOM is the name of the Anarchist newspaper (started by a scientist, Peter Kroptkin, last century — and circulation said to be rising quite quickly at the moment)!?

Now we come to the 'objectives'. Well, yes, there has been talk about pressing a button to vote via the media, but someone has shown that it would be extremely easy for hackers of some genre or another to juggle the figures by underground input — to their heart's content. Next, Big Brother is watching you . . . and 'the legislation is just and unambiguous', see, comrade no. 63 – or if you don't you it's Room 101 for you! (By the way, I'll control your mind — don't you argue with me — I'm a technician, and I've ceased to be meek!)

Now (to which we come at last) here's a thing. We must 'discover' those who are 'fit' and who can be 'trusted with power'. Who will do this programming? Why those who already have the power — and those with a drive or a thirst for it! Mr. Wakeham's near-religious faith in 'the technical fix' is touching, but hasn't he come across the ease with which you can twist any of that knowledge to say nearly anything you like! (Alas, just look at some of the fiascos of technology in recent times . . .) Yet this is not to say that technical projects etc. are not fascinating and action packed. But from the power point of view there is some nice work in existence showing a tendency for the growth of what might be called 'Techno-fascism'. There is no space to go into that here, but an eye should certainly be kept on it.

No, I'm afraid old Lord Acton was right when he said' Power corrupts, and Absolute Power corrupts absolutely.' Any technicians tempted to follow the absolutist path might like to try reading that excruciating book by Jacques Ellul called 'The Technological Society', and also that by Dr. Alex Comfort called 'Power and Delinquency in the Modern State', which has a whole lot of medical argument to illustrate the peculiar state of mind of anyone who is driven to seek political, or other, power over . . . No mention is made in these analyses to the effect that a God-like absolute truth can be found in any computer, IT processor, TV set, or Technician for that matter . . .

Yours sincerely,
Ken Smith
University of Kent
Canterbury.

I'm not sure I like that reference to my little piece, but it does strike me that the idea of technicians being qualified for power by virtue of their technical expertise is about as stupid as the idea that an actor might be fit to become President of the United States by virtue of his acting ability — Ed.

Write/Read

Dear Sir,

I have recently started to read (and hopefully teach myself) about electronics. I have bought a number of the publications on the subject and find that yours is by far the best. However, I am having difficulties and I hope that you may be able to help me.

My main interests are amplification and microcomputers. I would therefore be grateful if you could recommend any worthwhile reading on these subjects. The libraries in my area do not have any appropriate books, and of the books on the market I am stuck for choice. A typical question that you have probably heard before is this: is it worthwhile my investing in an electronics course, either by correspondence or in my local ITeC?

Yours,
J. Birch
St. Helens
Merseyside.

Advising on electronics books is difficult because I don't know what level you've reached or what your special needs are. I can only suggest you find a good college or university bookshop and browse, until you find the book or books that seems readable and addresses itself to what you want to know. I can, of course, also recommend that you read our review pages which regularly feature new textbooks. This might give you some idea of what's available. In general, practical experience is probably vital in order to develop an understanding of electronics. We hope our projects may be of some use, but undertaking a course of some sort is undoubtedly a good idea. I would recommend a college or an ITeC (if it's a good one), if only because the on-the-spot assistance you would get is invaluable — Ed.

What A Bind!

Dear Sir,

CHEAT.

I refer to the cover photo of the March 1985 issue, pretty impressive circuit board for a home constructor, but unless I'm mistaken (which I'm not) the board shown is resting (in peace) gathering dust on the top of my wardrobe, bought for a few pounds from a surplus store as a video game.

The probability that this is a genuine mistake is 9245804:1 (this is also my phone number). Now that's improbable.

Seriously though, keep up the good 'work' and how about a reward for spotting the deliberate error or a bribe to keep quite.

Yours hopefully,
A. J. Moore,
Liverpool.
(PS: I believe you are looking for good homes for binders).

Dear A. J., you're not wrong. We were going to offer you the bribe, but we blew it.

Mixing with JLH

Dear Sir,

Reference JLH's mixer of June edition 1985. I take the point that JLH is not aiming at 'ultimate fi' but would like to point out that the Gramophone input circuit as published strays by almost 5dBs in the upper bass region from the RIAA playback curve. This is easily remedied by changing the value of C34 from 49nF to 29.2nF (from 27nF and 22nF in parallel to 27nF and 2n2F in parallel), this, by chance, makes the values in the feedback very nearly those used by QUAD in the infamous '33'; can't be bad!

I would also like to recommend that an extra capacitor be added in parallel with the 'mixer pot' (RV12 as drawn), on the RIAA input stage. This will help the response at the higher frequencies where the attenuation of the series feedback arrangement tails off, the response will then be more like that of a 'shunt feedback' layout almost mentioned by JLH. In addition to the accuracy gained to the RIAA curve, this extra C helps particularly with scratches and other record noise. The value my 'BBC' and I recommend is 8n2F and is not significantly affected in the audio band by the setting of RV12.

Yours faithfully,
J. R. Charlesworth
Pickering
N. Yorks.

Help-line

Dear Sir,

I feel I must reply to the letter on page 15 of your May issue, from Mr. R. Leslie. Firstly, may I commend him on his action in taking his hobby further, but more importantly, I must warn him of the dangers of what he requests. In supplying equipment, a company should undertake to provide a service, that is to say the use of shorter than 40mm sliders provides no benefit, they are more difficult to adjust and more importantly if he has them made to order, then a customer with his machine may find that in a few years it is impossible to obtain a replacement if, for example, Mr. Leslie's company has dropped that product. So, in conclusion, by all means use custom knobs, but please don't add to the confusion of special spares available only from the manufacturer (or not at all). In my own work I have often had to scrap customer's equipment due to lack of availability of special spares.

Yours sincerely,
David McIntyre
Kirkcaldy.

Please send letters of Help-line queries or contributions to Read/Write, ETI, ASP Ltd., 1 Golden Square, London W1R 3AB. Any letter we receive may be published unless marked 'Not for publication', and we reserve the right to edit letters for reasons of space. We have received a note addressed to Help-line detailing a commercial service. Please note that the place for commercial services to advertise is in the classified section of ETI. **ETI**

I tell you, there was no gate marked on the drawings!
Another ETI design.
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THE REAL COMPONENTS

Prepare to be LED along even stranger paths as John Linsley Hood tunnels his way into the eerie world of diodes.

I looked, when I was describing how transistors evolved, at the basic P-N junction (Fig. 1). These are created by taking a rod, some 2-4 inches in diameter, of very highly purified silicon or other semiconductor material in single crystal form, and cutting it into slices with a diamond edged circular saw. The very thin discs so formed are cleaned and polished, and finally heated in a vacuum oven with a carefully chosen atmosphere so that selected impurities will diffuse into the semiconductor material to a precisely controlled depth.

Silicon is tetravalent, which is to say that the atomic structure is such that there are four surplus valency electrons present in the outermost electron shell within the atom. If one diffuses in a trace quantity (one or two parts per million) of an impurity such as arsenic which is pentavalent (it has five outer orbital electrons), the net result will be that there are some 'spare' electrons floating around in the crystal structure.

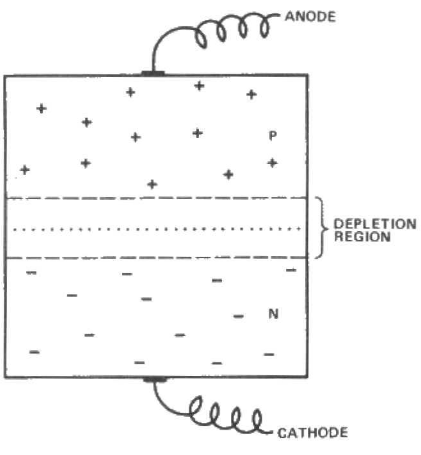


Fig.1 A basic PN junction.

We call such a material an N doped silicon, or simply N type. If the material is heavily doped, we call it N+, if it is lightly doped we call it N— and so on.

Similarly, if we diffuse in boron which is trivalent (it has only three outer valency electrons), the result will be a number of holes where electrons should be, but are not. These holes behave like positive electrons, but are a bit more sluggish. This is because their movement takes place only as a result of an electron coming from somewhere else to fill the gap, leaving another hole where it had been, and so on. I like to think of this as a kind of electronic leap-frog.

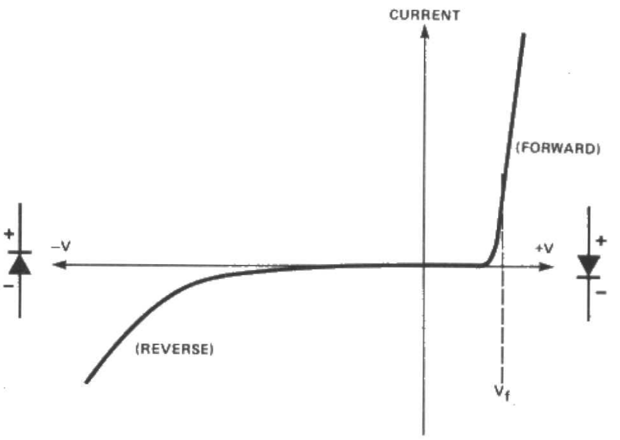


Fig.2 Voltage/current characteristic of a junction diode.

When a P and an N doped semiconductor material are in contact, usually as a result of deliberately contrived impurity zones within the single crystal slice, there occurs a diffusion of these 'spare' electrons and holes across the junction. This leaves a depletion zone on either side of the notional junction region which is completely stripped of both holes and electrons, as shown in Fig. 1.

This depletion region is, therefore, effectively a non-conductor, so even in the conducting direction of the diode it is necessary to apply a certain forward voltage before any current will flow, to give the electrons enough kinetic energy to traverse the potential gap.

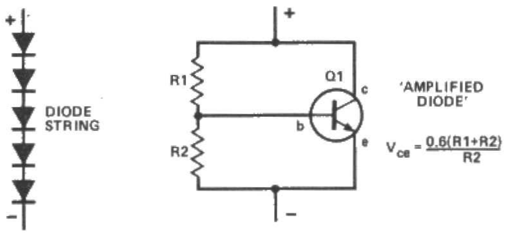


Fig. 3 Arrangements which can be used instead of a zener diode where a voltage drop is required in low noise circuitry.

The effect of this is to make the depletion zone appear to decrease in width, to the point at which it disappears when the forward conduction potential for the junction is reached. The converse is true for a reverse biased junction.

This results in the voltage/current graph shown in Fig.2a. A very important characteristic to note is that the forward voltage drop, Vf, for a diode connected in its forward biased mode is one of pure conduction and is therefore not very noisy, whereas operation in the reverse conduction mode is very noisy indeed.

So, when you need a voltage drop in low noise circuitry, use a string of forward diodes or an 'amplified diode' as shown in Fig.3 rather than a zener diode, in which the conduction occurs as a result of reverse breakdown.

A consequence of the greater mobility of electrons and holes as a result of thermal excitation is that the forward voltage drop of a PN diode decreases with temperature. This seems to contradict the concept that the depletion region arises as the holes and electrons migrate across the junction, so that greater mobility of these should cause a wider depletion zone, but in reality the increased carrier mobility simply acts to lessen the forward bias which needs to be applied before conduction occurs.

However, an important feature of doped regions is that the width of the depletion zone at the junction decreases as the impurity concentration, and the consequent number of holes and electrons, is increased. This phenomenon is used in tailoring device characteristics, as shown later.

Small Signal Diodes

There are three different types in general use:-

Germanium point-contact diodes, useful for very low level signals in radio applications, but otherwise tending to become obsolescent.

Germanium diffused junction diodes, similar in characteristics to silicon ones, but with a lower forward voltage drop (0.15V typically, as compared with 0.55V for silicon), worse reverse leakage current (by a factor of about 1500x), and worse temperature coefficient and maximum working temperature.

Silicon diffused junction diodes, such as the 1N4148. These are inexpensive and very reliable (if from a good manufacturer), and can be used as low power rectifiers up to about 30V RMS and 50mA. Their four nanosecond recovery time (the length of time which it takes for the electrons and holes generated by current flow to recombine, so that the diode would be non- conducting in the reverse biased direction) limits their use to about 100MHz. For higher frequency use more suitable diode types are available.

Power Rectifier Diodes

These are basically similar to the small signal diode. However, the power handling capability of the diode is determined by the maximum junction temperature, which, in turn depends on the conducting resistance of the diode which determines the power dissipation for any given current and the ease with which the heat generated in the junction can diffuse away. These will usually have a large junction area to minimise the conduction resistance, in good thermal contact with a metal plate or stud whereby the heat can be taken to some kind of heat sink.

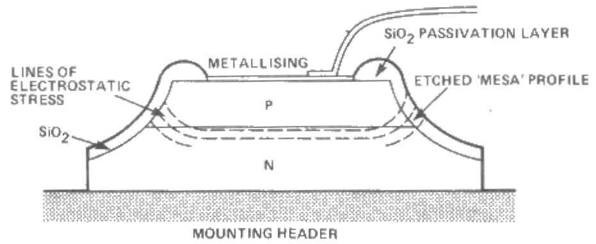


Fig. 4 The sides of a high voltage rectifier chip are etched away at an angle to deflect electrostatic stress away from the edge of the junction.

Also, such diodes must be able to withstand a high reverse voltage. This is achieved partly by their junction geometry, as shown in Fig.4. In early designs of rectifier diode, it was noted that failure almost always took place at the edge of the junction area. If the sides of the chip are etched away at an angle, the electrical stress at the edge of the junction can be reduced so that this kind of breakdown is prevented.

The other technique employed is to keep the doping impurity levels relatively low, so that the depletion region is wider and the stress, per unit thickness, is consequently less. This, unfortunately, increases the resistance of the silicon per unit area with a consequently higher forward voltage drop - hence more thermal dissipation for a given current. In lower voltage rectifier diodes relatively high doping levels will be employed, simply to reduce the forward conduction power losses.

Avalanche Diodes

A further technique which is used in power rectifiers is to tailor the diffusion process and the doping levels of the P and N regions on either side of the junction so that the depletion region is very uniform in thickness. Then, provided that the doping levels are not too high, any carrier (electron or hole) entering the depletion region under conditions of reverse bias will be so accelerated that impacts with atoms will generate further electron-hole pairs. These, in turn, will be accelerated by the applied electric field and will collide with other atoms, giving rise to a situation very

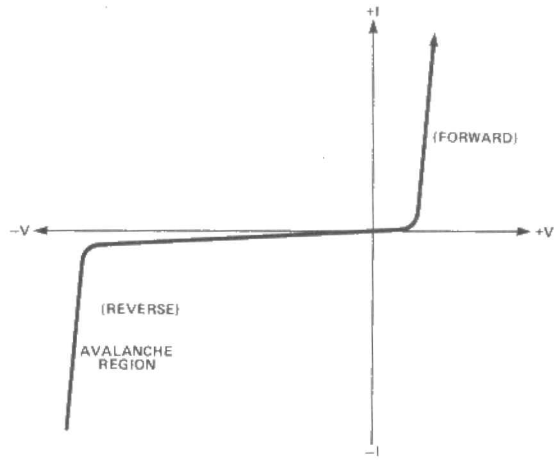


Fig. 5 Voltage/current characteristics of a typical avalanche diode.

similar to that of an avalanche of rocks falling down a sloping hillside.

This process is known as ionisation but is most commonly seen only in gases, such as neon signs or sodium vapour street lamps.

The purpose of the avalanche diode approach is to avoid destructive damage to the rectifier occurring as a result of very short duration high voltage spikes. These arise all too frequently on power lines. A straightforward rectifier diode could break down under these conditions, and the very high temperatures generated by even small local current flow at high reverse voltages could fuse portions of the junction, leading to a short-circuit.

A typical voltage/current graph for an avalanche diode is shown in Fig. 5. In a well designed device, the reverse turn on is very abrupt and conduction will be distributed uniformly across the whole of the junction area.

Although a maximum static thermal dissipation of some tens of watts might be permitted for such a diode, this could well absorb a spike energy equivalent to tens of kilowatts for a duration of only a few microseconds without any harm.

Zener Diodes

These are very heavily doped diodes, with, in consequence, a very thin depletion region between the PN junction. The reverse bias electrical stress across this causes ionisation of the semiconductor material in the depletion zone, and consequent current flow. Beyond about 7V, zener diodes are not used. All of the so-called zeners above this voltage will, in fact, be avalanche diodes. As mentioned above, reverse leakage current is noisy, and a zener diode will make quite a good wide-band noise source.

The fact that zeners are all very highly doped tends to give them a low and fairly sharp turn-on characteristic in the forward direction, which can be useful.

High Frequency Diodes

The major requirements in this application are high carrier mobility and low junction capacitance. These requirements are met fairly well by the old point contact or gold-bonded Germanium diodes, but the most commonly employed type nowadays is the Schottky diode, shown in Fig.6a. This relies only on majority carrier action (electron flow), and is, in consequence, fast in action. The snag is that there are sharp corners where the metal inlay abuts on the N type silicon slice, and the electrical stress at these points leads to a low reverse breakdown voltage which can be as little as 5V. The advantages of this construction are that the forward voltage drop is reduced to some 180-220mV, and that the operating frequency can be as high as 18-20GHz.

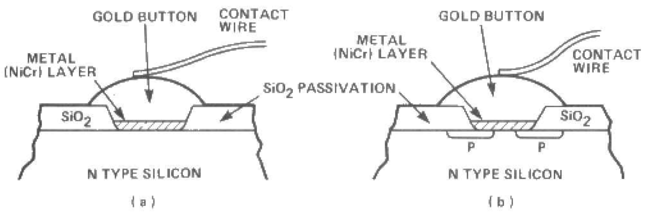


Fig. 6 Cross-sectional views of a) a normal Schottky diode and b) a hybrid Shottky device.

The electrical stress at the edges of the metallic layer in a Schottky diode can be lessened by the inclusion of an annular ring of P-type silicon under the edge, as shown in Fig. 6b. However, although it can increase the reverse breakdown voltage to 60-70V, the maximum operating frequency is reduced to about 4GHz. These are sometimes called hybrid Schottky diodes.

Depending on the construction employed, the junction capacitance can be as low as 1pF - compared with 5-50pF for a standard small-signal silicon junction diode and 500-5000pF for a rectifier diode.

An important characteristic of diode behaviour, which influences pulse and switching performance in addition to RF behaviour, is the transient response of the diode junction. This is determined by a variety of phenomena such as:-

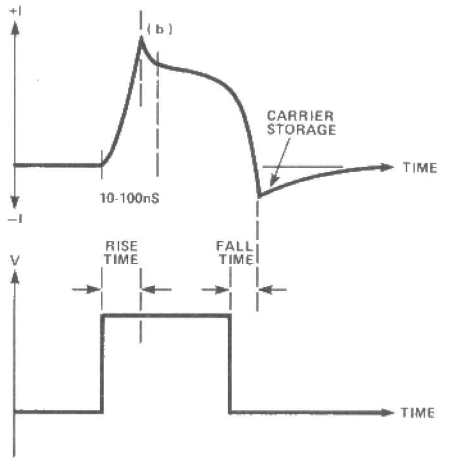


Fig. 7 Carrier storage following a reversal of the applied voltage in a PN junction diode.

Carrier storage, due to the minority carriers (holes) still left uncombined at the conclusion of a forward conduction period. This causes conduction to continue for a short period following a reversal of potential, as shown in Fig. 7a. The stored charge can be expressed in pico-coulombs (1 coulomb is the charge stored in a 1 farad capacitor at an EMF of 1 volt), and typical values are 100-10,000pC.

Turn-on transient, due to the time taken for conduction to settle down to a steady value. Typically 10-100ns for a small-signal silicon junction diode.

Voltage dependence of junction capacitance is a characteristic which is exploited in varicap diodes, but occurs in all reverse-biased PN junctions and has some of the characteristics of inductance.

Varicap Diodes

The capacitance of a reverse biased PN junction is, roughly, inversely proportional to the square of the

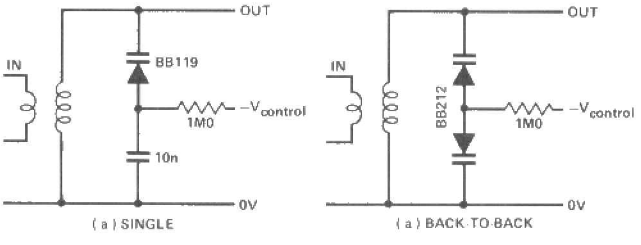


Fig. 8 The use of varicap diodes to provide remote voltage controlled tuning.

voltage across it. Such a diode appears to consist of two conducting regions separated by the depletion layer between them, which acts as a dielectric. Typical devices have capacitance values in the range 3-50pF, depending on device and applied voltage.

The way in which they can be used as a remote voltage-controlled tuning element is shown in Fig. 8. Back-to-back connection is frequently employed where large signal levels are likely, to prevent the signal voltage itself from modulating the capacitance.

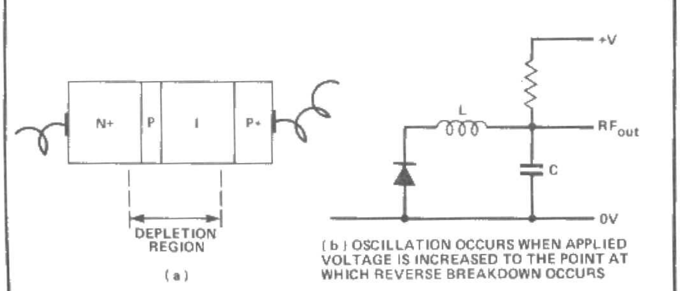
A similar type of construction is employed in the varactor diode, in which the diode is connected across an oscillator coil and the dependence of the capacitance on instantaneous voltage is used to generate harmonics of the signal.

Step Recovery Diode

This is a device which is designed, by geometry and doping levels, to have a very abrupt switching characteristic when the applied potential is reversed. It can be used to shock excite a coil into oscillation at a much higher frequency (up to the sixth harmonic) than the input voltage. This is useful for microwave signal generation, as is the impatt diode.

Impatt Diode

This is a device whose design is deliberately contrived to give a very wide depletion layer, assisted by the inclusion of a layer of intrinsic (un-doped) silicon, in the form shown in Fig 9a. When this is used in the type of circuit shown in Fig. 9b., quite useful amounts of microwave power (up to 1W CW at 50GHz, or 50W pulsed) can be generated. The trepatt diode is a structural modification of this to cause bunching of the electrons, which allows some increase in power levels.



(b) OSCILLATION OCCURS WHEN APPLIED VOLTAGE IS INCREASED TO THE POINT AT WHICH REVERSE BREAKDOWN OCCURS

Fig. 9 The construction of an impatt diode and b) a microwave power oscillator using the device.

Gunn Diode

In spite of its name, this isn't really a true diode at all. Made from N-type gallium arsendide, it is what is known as a two-valley semiconductor in which the conduction band (that energy level in which the electrons can move as in a normal conductor) has two different levels, with different mobilities.

When current is caused to flow through a slice of this material between two ohmic contacts, the fast electrons overtake the slow electrons to form a bunch which travels through the slice. The result of this is an accumulation of charge at the cathode, until it neutralises the field due to the applied voltage at the contact. Charge accumulation then stops, and the charge domain then travels through the semiconductor slice in the form of a sharp spike of current at a speed determined by the applied voltage. This process then repeats to generate a rapid series of such spikes.

Such devices are often used as the microwave power sources in such things as microwave Doppler intruder and fire alarms.

Tunnel Diodes

A decade or so ago, these devices were seen as the bright new hope for simple RF oscillator circuits. Unfortunately, their price never became low enough for them to achieve popularity, and they may soon become just a historical curiosity. They are based on the use of a very highly doped junction, with a consequent very thin depletion layer.

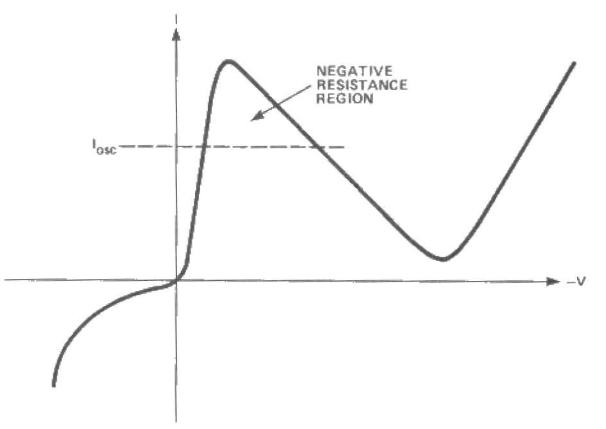


Fig. 10 Voltage/current characteristics of a typical tunnel diode.

At very low reverse bias levels, the thermal energy of the electrons in the semiconductor is high enough for them to 'tunnel' through this depletion layer, and the junction conducts. However, as the reverse voltage is increased the thickness of the depletion layer increases, so the tunneling effect, even with an increased potential difference, begins to lose ground. The current then begins to fall as the potential is increased, giving what is known as a negative resistance characteristic .

In due course, the leakage current begins to increase once more leading to the type of reverse voltage/current graph shown in Fig 10. If this is connected in series with a coil as shown in Fig. 11, a simple HF oscillator circuit with a stable output voltage is produced. However, tunnel diodes are quite easily damaged by excessive currents.

Light Emitting Diodes

Apart from the ubiquitous transistor, this is, I think, the bit of modern semiconductor technology which has made the biggest impact on the public at large, as a long-life replacement for filament indicator bulbs.

These work because radiation is emitted by an atom when an electron, having been excited into a higher energy level by some input of energy such as a current, falls back into its original rest level; a similar mechanism operates when an excited electron falls into a hole. The process is known as electroluminescence.

Since the light is emitted from the junction, the diode must be designed so that the light can escape, and usually they are encapsulated in a plastic moulding so designed that it acts as a magnifying glass with the junction at its focus. In order to get radiation emitted in the visible part of the spectrum, it is necessary to have a material with a large energy band gap, such as gallium arsenide (red), gallium arsenide phosphide (amber and yellow), gallium phosphide, (yellow or green, depending on doping).

Early LEDs were not very efficient in terms of the light output for current input, efficiencies of the order of 0.005% being not untypical. However, more modern 'high-brightness' LEDs can reach 3% efficiency, especially in the red coulours where they are beginning to compete with filament bulbs. Also, by tailoring the geometry of the device, semiconductor lasers are possible and these are used as the 'reading' device in compact disc players.

Care must be taken not to reverse bias an LED (light is emitted when current flows in the forward direction) since reverse breakdown will damage the device. An LED can be used on an AC source if it is shunted by an ordinary silicon diode as shown in Fig. 12.

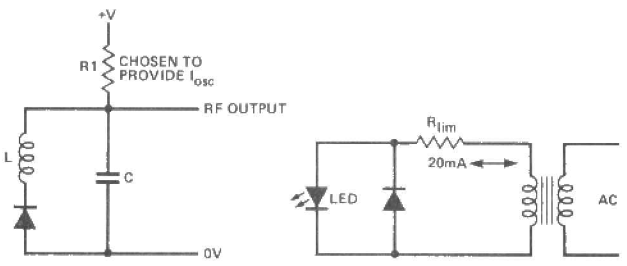


Fig. 11 (left) A simple HF oscillator circuit using a tunnel diode and Fig. 12 (right), driving an LED from an AC supply.

Reverse Leakage

This is one of the major problems with semiconductor diodes, apart from reverse breakdown, and is strongly dependent on temperature. Such leakage currents increase by 10% for each 1°C rise in temperature, which means that the leakage current will double every 8°C. This sets an upper limit for the use of germanium diodes at about 70°C and for silicon at about 160°C.

Although diodes do not appear to have a lot to do with ICs, most microcircuits are made on a substrate of silicon with all the bits of circuitry isolated from the substrate simply because they are sitting on top of a reverse-biased diode junction.

As I mentioned above, such leakage currents are noisy, and this was (and to a lesser extent, still is) the reason why low noise circuits built up from discrete semiconductors would often be better than their op-amp equivalents. However, technology improvements have lessened this penalty, and nowadays, for most practical purposes, if an IC is available to do the job it is not sensible to do it any other way.

Having said that, I propose to have a look next month at the world of the linear IC, with particular reference to the operational amplifier.

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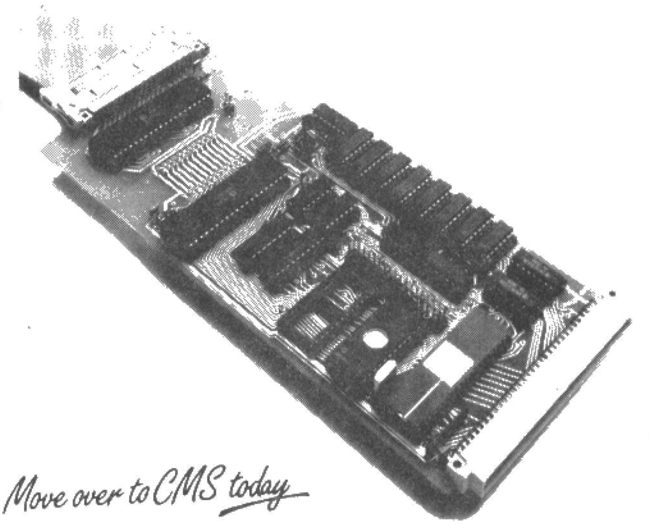

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NOISE ABOUT NOISE

In this personal view, hi-fi designer Neil Munro sounds off about about power supplies, capacitors and hi-fi designers with audible results.

I had always thought that the only real differences in pre-amps were down to hiss and the facilities offered, once adequate specifications had been achieved. But then, in between repairing and designing various small bits of hi-fi, studio and PA equipment for others, I knocked together a disc pre-amp for myself. I brought it to the shop where I was working at the time and one of the sales staff set it up for a comparison with a newly introduced, expensive commercial design. I sat down, closed my eyes and listened. To my amazement, my pre-amp gave a noticeably clearer and less cluttered performance. I could hear the difference.

Since both pre-amps used broadly similar circuitry (based on the NE5534 and TL072 op-amp chips), both had less than 0.01% distortion at normal levels and both had similarly accurate EQ, I had no idea why they should sound so different. I set about developing the design, replacing the moving magnet input with one for a moving coil cartridge. After playing with several ideas, I found the familiar LM394/NE5534 hybrid configuration worked well. Unlike a similar circuit by Barry Porter, published in ETI, December 1983, I filtered the supply to the LM394 input 'pair' and was rewarded with perfect stability and a sensible slewrate. This MC circuit was predictably noisier than my original pre-amp but it sounded even clearer. I could easily tell if three or four voices were singing or if a guitar was nylon or steel strung.

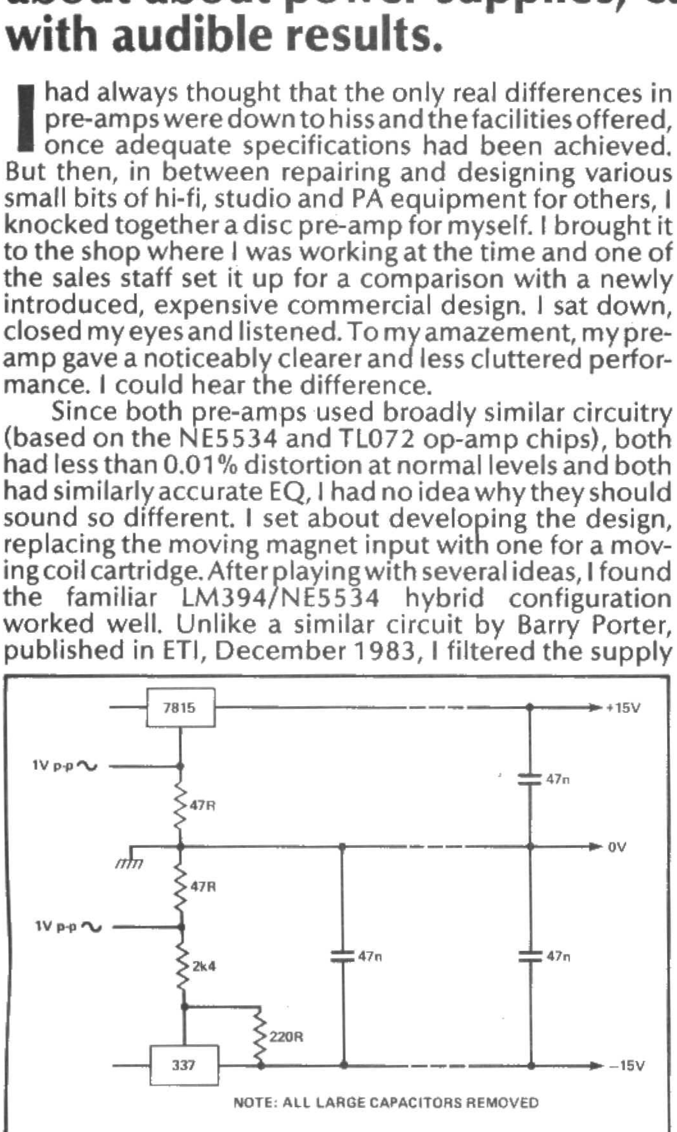


Fig. 1 Injecting modulation into power supply.

This didn't seem to me to be entirely due to cartridge variations, since a very expensive commercial MM pre-amp was just as clear. I was puzzled. What was behind all these evident differences?

I checked for marginal stability in the 5534 circuit, but it was fine. I considered power supply rejection in the 5534 stage. The MC circuit used a 5534 stage and it performed very well. In fact, the 5534 has a stated power supply rejection ratio (PSRR) of 100µV/V and a stated common mode rejection ratio (CMRR) of 100dB. But this started me thinking. The figures are referred to input and should be reduced by whatever gain follows. They're also quoted at DC. And then there was the fact that the MC circuit's gain comes mostly from the LM394 input 'pair' while the 5534's inverting and non-inverting inputs are fed from equal impedances - so that it should have an easy job.

I felt that I needed to check the real wideband PSRR referred to output, in order to get a true idea of what would happen when you actually listened to some music. I rigged up a power supply with a modulating input (Fig. 1), injected 1V p-p on both the positive and negative supply rails and checked the output of the MM circuit. The modulation appeared at —30dB to —40dB. Taking into account an assumed figure — 70dBV for main supply noise, the modulation noise would drop to —100dB to —110dB when referred to a nominal 1V output from the pre-amp.

This was good news. But when I came to replace the 330 ohm dummy load at the input to the pre-amp with a real MM cartridge (typically 500 R + 1200mH), my jaw dropped slightly. In the 5-20kHz region, the modulated supply noise increased to —10dB. With the power supply back to normal and the cartridge still in place, I found that high frequency input signals gave up to 3 mV or— 50dBV of rubbish, which could appear at the output at a worrying —60dB. On the other hand, when I came to test the MC circuit I found that it fared well with a real cartridge in place (these are predominantly resistive at between 3R5 and 30R. It was even acceptable open circuited: —30dB to —40dB except at 20Hz (and this was cured by enlarging the input coupling capacitor and using an active filter for the LM394 stage). The trouble with that capacitor was that low frequency reactance caused an impedance mismatch which reduced CMRR. And on reflection, I realised that it was the inductance of the MM cartridge that caused a mismatch on the inverting and non-inverting inputs to the 5534 op-amp, which ruined the PSRR and CMRR figures for the MM circuit (Fig. 2).

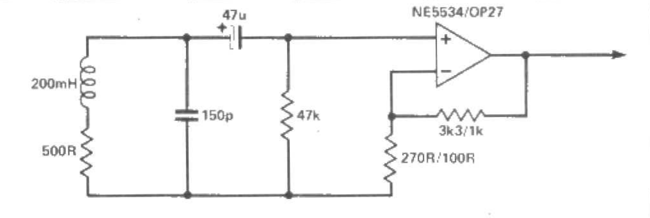


Fig. 2 PSRR test circuit with MM cartridge.

The Heart of Noise

These things were all curable, yet they didn't reach to the heart of the problem - the power supply noise in an actual circuit. Clearly, the first place to look for noise in a regulated power supply is the regulation itself. I was using 78/79 types and, as luck would have it, their quiescent noise (20-20kHz hum and hiss) was —70 to —80dBV. Later, I bought a batch for evaluation and found that some showed as much as —40dBV and often came complete with nasty splutterings.

But that's only part of the story. In operation, active circuitry tends to draw varying current. In Class A amplifiers, this is in step with the signal, but in Class B it becomes half-wave rectified as the positive and negative sections of the audio signal are driven into low impedance loads. The output impedance of the supply and the impedance of intervening wires and connectors become important, introducing modulation on the IC terminals. From this point-of-view, the *quality* of the power supply is irrelevant. What matters is the modulation.

The all-too-common practice of decoupling with a filter (typically, composed of a 10R resistor and 10uF capacitor) can actually make things worse because it assumes that the local signal common is 0V. But conventionally, the 0V rail is also signal common and should be treated as a signal path. You wouldn't connect capacitors from the supplies to the actual signal path, because they will inject noise and modulation rubbish into it which, because of the practical finite impedance of the signal path, will produce a potential that adds to the signal output.

A 10μF capacitor also has an impedance of 8ohms at 20kHz, so signal modulation will be worse. Using a larger capacitor, say 470μF, will help - but at the cost of injecting noise more efficiently (Fig. 3). The only really effective approach - if an expensive one - to ensuring stability on the signal common is to use local active regulation. Even here, care must be taken to avoid injecting DC or other noise into signal common.

Another problem resulting from the finite impedance of signal common is that heavy load currents will generate errors. This is usually inoffensive from an acoustic point-of-view, but with disc input stages the feedback current is the pre-emphasised version of the signal with high frequencies boosted. The result can be nasty harsh noise when added to the equalised output. There are several methods for avoiding this - the use of true independent supplies in different stages, differential sensing of output, shunt feedback or 0V regulation. I chose the last of these as it kills two birds with one stone (Fig.4). The feedback is handled by a local op-amp that transfers it to the opposite supply line instead of signal common - effectively reducing signal common impedance to the output impedance of the op-amp (for ½x5532 in unity gain configuration this is 10 milli ohms, rising to 30 milli ohms at 20 kHz). Also, the increase of current in the stage output is complemented by a reduction in the 0V regulator - which means that while the amplifier is operating in Class A mode (about 99% of the time), overall current consumption is constant.

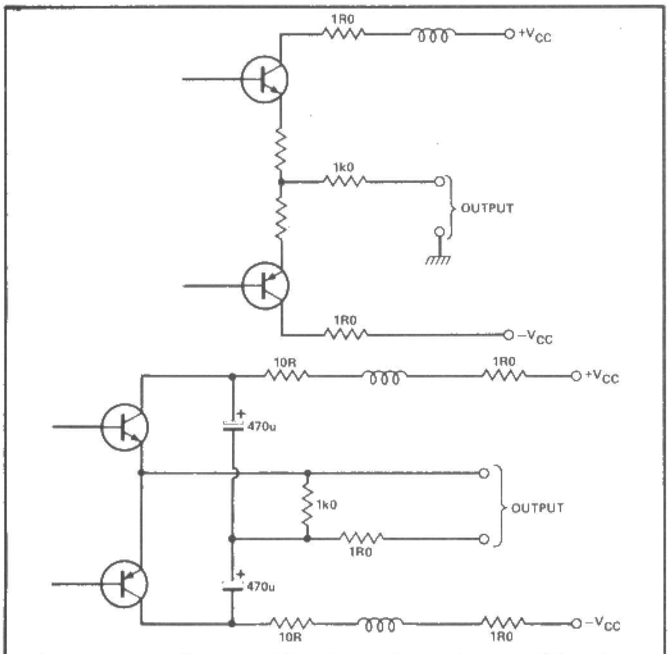


Fig. 3 PSU noise resulting from impedance of leads and signal common corruption in class AB out- put stage.

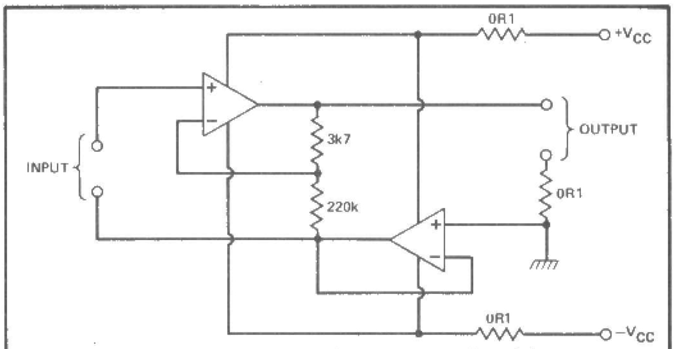


Fig. 4 Constant current series feedback giving 0V regulation.

This is especially important in a modular design like ours, using stage connectors, since the power supply modulation is negligible.

My comments on the 5534 op-amp and the 78/79 series voltage regulators are not intended as slagging. I'm sure the original designers would fall about laughing if they saw some of the uses these devices are put to. The 78/79s are perfectly good general purpose regulators, but they're not intended for precision supplies. The computer-optimised LM340 series (for example, the LM340T-15) are consistenly better, though the complementary LM320 series is rather expensive for negative supply regulation. The LM337 series are better value, especially if TL072s are used, since their negative supply input is very noise sensitive. The 5534 is an excellent line processing block when driven from lowish kilohms with clean supplies. The power supply circuit shown (Fig.5) has noise in the 20-20kHz range better than - 80dBV with 100mA drawn and an output impedance of around 0R3 at 100kHz thanks to the 470μF output capacitors.

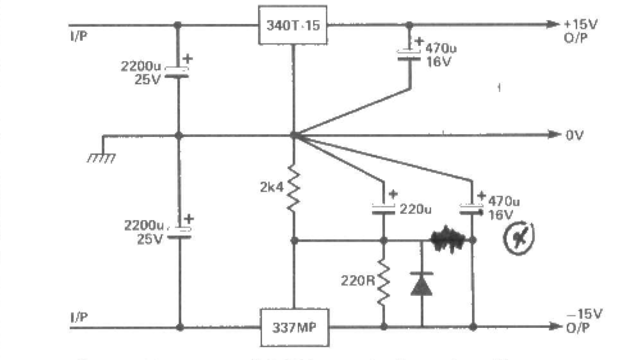


Fig. 5 Suggested PSU regulation circuit.

ⓧ ABOVE ERROR / CORRECT OOPS! FROM P 62
FEB ETI 1986 OF Ⓓ

On the general topic of power supply decoupling, the use of separate filters for each channel is not recommended. It would be rather like isolating two people with the same contagious disease - it doesn't cure either of them. It's actually useful to have two channels sharing the same supply at each stage, since one can be driven with a signal and the other used to detect any noise generated in the process.

A Couple of Points

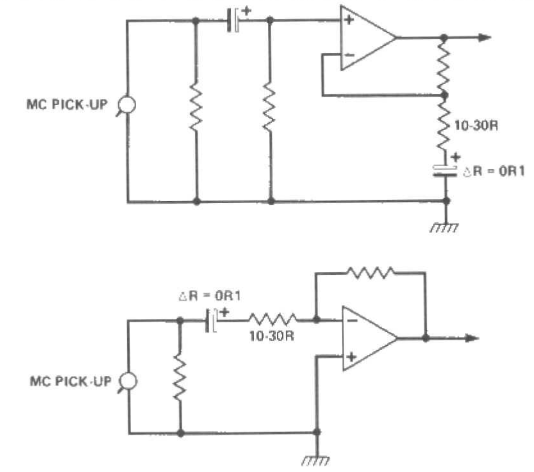
And now to capacitors. A 1958 Radio & Electronics handbook that I unearthed has an excellent section on power supply topography and mentions that paralleling a 220μF electrolytic with a 100nF film type overcomes some of the problems connected with the equivalent series resistance (ESR) and leakage of the electrolytic. I was giving my mother hell for bringing me into the world when that was written and it still applies if you're talking about the stability of wideband amplifiers - as long as the bypass capacitor is placed close to the circuitry not the power supply. But anyone who believes that such bypassing has a significant effect in the audio band either hasn't bothered to look into the characteristics of modern electrolytics or is still using 27 year old ones!

For example, the 220μF/16V cap used in my power amp feedback decoupling has an ESR of 0.3 to 0.4 ohms at 20kHz and 15°C (it was winter!). A 470nF polyprop/polyester/polyanything has impedance of 17ohms under the same conditions - so what's bypassing what? It's only when you get above the 500kHz range that inductive reactance starts taking over and the impedance of electrolytic and film cap begin to match. Bypassing at ICs can be important because inductive suplies in the MHz region can easily cause instability, but 10-47nF is quite adequate, cheaper and lessens noise injection into signal common.

And then you should be asking yourselves, why the pursuit of pure capacitance in coupling components? Ideally, a coupling component should block DC and have zero or constant impedance from at least 20Hz up to 20kHz. A perfect capacitor would do the former but would have 1000:1 variation in impedance over the audio band. Admittedly, in dB terms this variation is miniscule, but the point still stands. Now, a large electrolytic can approach the second requirement for a coupling component. The variation of impedance with frequency in an electrolytic is not simple and there is a 'break' frequency at which the slope flattens out. The electrolytic can be chosen so that this frequency is very low and in the critical mid to high frequency area ESR is practically constant. Inductive reactance is negligible below about 500kHz in any reputable make of capacitor in the sub 1000μF range.

So why do electrolytics sometimes sound odd? I've found that ESR can vary, particularly with temperature, by up to 0.1ohms. In conjunction with a 10R resistor - as in all too many MC inputs (Fig.6) - the variation can amount to - 40dB. With considerably higher resistances (above 1 kilohm), this figure drops to - 80dB or so.

Voltage modulation can also affect the performance of coupling electrolytics. In a competently designed circuit an electrolytic is operated well above its break frequency so that the voltage drop across it is a small fraction of the applied voltage - at most hundreds of millivolts. I have found no evidence of acoustic effects at this level. Even these slight reverse voltages can be eliminated by using predictable offsets to polarise the electrolytics to the peak expected reverse voltage. We have done this with our design, and while I'm not convinced that it has any significant impact, it certainly does no harm (Fig. 7 and 8).



EFFECTS OF VARIATIONS IN ESR IS PROPORTIONAL TO RESISTOR THAT IT ACTS IN CONJUNCTION WITH

Fig. 6 ESR variation in electrolytics - typical configurations.

Electrolytics may also suffer from microphony - a feature used to positive advantage in capacitor microphones. At 200μV sensitivity, microphony in input and feedback capacitors in an MC input stage is hardly surprising, although it varies with type and make. Generally, tantalums produce a 'boing' while aluminium electrolytics give a duller 'dumph' — which may explain why tantalums are out of favour. In both cases, mounting in a dollop of silicon rubber helps enormously, damping the resonance due to vibration of the body relative to the leads. Incidentally, other components can suffer from

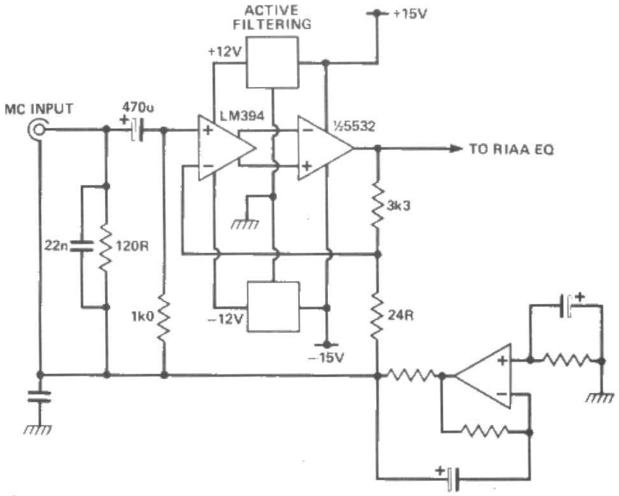


Fig. 7 Basic configuration of MC pre-amp input stage.

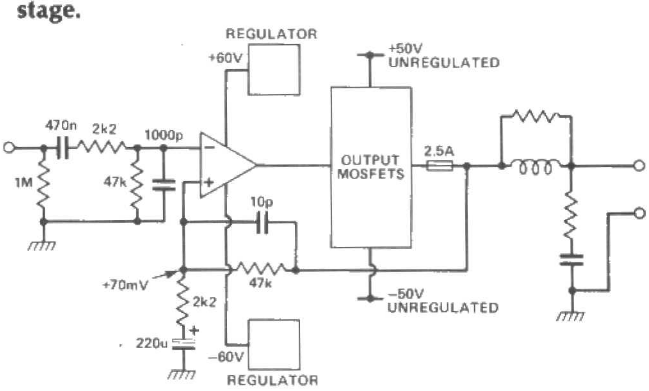


Fig. 8 Basic configuration of power amp module.

microphony — particularly FETs. It can be helpful to gently tap all components with a plastic pen to test them.

When it comes to power amp main capacitors, bypassing becomes even sillier. To achieve 100 milliohms at 20kHz would require 80µF of pure capacitance (can I speak to the bank manager, please?). There is no substitute for low ESR electrolytics, now widely available thanks to their development for switch-mode power supplies. Sprague, Mullard, STC and RIFA all do 10,000uF 63V types with a specified maximum of 26 milliohms at 10kHz. In most cases a few inches of wiring is enough to equal that.

Stiff and Nonsense

Before getting obsessed with basic power supply impedance, it's useful to stop and ask, 'why does it matter?'. In a sense, the only power supply to an amplifier is usually the mains, conditioned as required for the sake of convenience so that an input voltage can control this power source to produce an analogous output. All too often, designers — especially the strange hi-fi breed — become obsessed with the intermediate energy store (that's all a PSU is) and do not view the systems as a whole. So we get beliefs about 'stiff' supplies using massive transformers and capacitors with the idea that this will achieve quality, not just (overkilled) quantity. Once you realise the irrelevance of this, you can start investigating what it is about the intermediate store that corrupts the process by which it is controlled by an audio input voltage.

There are many more complicated factors than the ones I've been able to deal with here: induced coupling from supply and load cables to the input stage, transformer induced hum, the accuracy of reference points, as well as capacitative coupling and voltage modulation. Voltage modulation is crucial — which seems blindingly obvious to me since, if the power rails are jumping up and down, then they will hinder the 'brains' of the operation in carrying out its task. The most effective way of preventing this happening is to regulate the driver section and only let the output stage suffer the abuses of a jumpy supply (Fig. 8). In our design, this results in crosstalk noise on one undriven channel of —110dB at 20Hz while the other channel is delivering 75W into 8 ohms. As I mentioned earlier, in connection with the pre-amps, a common supply is used for both channels, so the figure shows true rejection capabilities.

As with all engineering, there is no 'right' answer to the subtle problems of audio design. There are only better answers judged against a whole range of criteria: subjective sound quality, cost, reliability, consistency, availability of components and, for a commercial product, appearance and the quality of the finish. As for the designer's ego — well that can be massive. An important part of designing is to get an 'objective' assessment of the results of process. It's too easy to convince yourself that a technique will improve performance and so find, through your prejudice, that it does. It's equally easy to find yourself not knowing when to stop developing a design, even though the improvements you are making no longer affect the final sound.

I've concentrated on power supplies because far too often they are just an afterthought tacked on to some sophisticated low noise, ultra low distortion circuit. In reality, the PSU and the circuit itself are complementary and must be designed together taking only the mains AC input as given — warts and all.

The thing I find most astonishing is that all this is well known. That 1958 book I mentioned analyses power supply design and the various corruptive possibilities very clearly. Yet too many designs still completely overlook these things. Part of the blame, surely, lies with the approach to ICs that takes them as perfect circuit building blocks. It's an approach encouraged by the very existence of ICs. Using them, you can throw a circuit together that will work fairly well. Using discrete components requires understanding to get the circuit to work at all. The pay-off is that the shortcomings of your design are far more obvious. Although a contented user of ICs, I strongly recommend that full data and internal circuts be consulted and that the chips are treated not so much as ICs but as CIs — circuits that have been integrated, a subtle but philosophically fundamental difference.

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OOPS!

Corrections to projects are listed below and normally appear for several months. Large corrections are published just once, after which a note will be inserted to say that a correction exists and that copies can be obtained by sending in an SAE.

AM/FM Radio (November 1984)
In Fig. 2, the oscillator and IF sections should be shown connected to ground; the PCB is correct. In Fig. 4, C31 should be 10n to give the 75us deemphasis shown in Fig. 3, but 4n7 has been found to give a brighter midrange. R38 in Fig. 5 should, of course, be 820k rather than 280k and it and the bottom end of C38, C44 etc should be shown connected to ground. In the construction section on page 25, four pieces of 8mm plywood are mentioned but in fact only three are needed — the fourth side is the front panel. See also the note in December News Digest regarding availability of the inductors.

Digital Control Port (November 1984)
The second sentence in the "Testing" section on page 30 should include the words 'without any ICs in place'. In the second paragraph of that section, the check for +5V should be made on pin 3 of IC101, not IC1. At the bottom of the first column on page 31, the last sentence should finish with B3 = 0.

Video Vandal (November 1984)
In Fig. 8 on page 54, R16 and R17 should be shown connected to the base of Q4, and C12 and SW2 should be in the D output line rather than the OV line. It may also be beneficial to add a diode across R3 with its anode connected to the slider of RV1. In Fig. 10, R52 and LED2 are shown connected across the +12V supply but it is better to place them across the −12V supply so as to even-up the dissipation in the ICs.

Electron Speech Board (November 1984)
In the parts list on page 58, IC3 should be listed as a 74LS273.

Digital Delay Line (December 1984 - January 1985)
In Fig. 6 on page 21 of the December issue, C19 and C20 are both 100uF. In Fig. 8 on page 62 of the January issue, C3 should be marked 33p. On the overlay diagram (Fig. 9, p.64), R37 is missing and should be connected between pin 3 of IC9 and the 0V line; R20 is missing and should be located in the holes immediately to the left of R18; R50 is missing and should be connected between pins 1 & 2 of IC14. Some components on the overlay have also been wrongly numbered:- C20 should be marked C19 and C21 should be marked C20; R12 (between ICs 5 & 6) should be marked R22; R48 should be R44, R49 should be R45, R57 should be R46, R51 should be R47, R50 should be R48, and R47 should be R49. The unmarked capacitor directly above what is now C19 is an un-numbered 100n ceramic. C30 does not appear on any diagram or parts list and this is correct.

"Sonneti" Combo (March 1985)
The foil pattern on the overlay diagram has been shown as though from the copper rather than the component side. The foil is correctly shown on the Foil Patterns page from the copper side.

VCDO (March 1985)
RV2 should be 10k (right in parts list, wrong on circuit diagram).

Single Board Controller (March 1985)
There were a number of errors in the parts list. RP2 is listed as a 10k SIL pack but is actually four separate resistors, and the same applies to RP3. RP4 is also listed as a SIL pack but should consist of seven commoned resistors. R13 is always required, not just when a cassette interface is used as stated.

Heat Pen (June 1985)
The instruction in the penultimate paragraph on page 49 should read "... adjust RV2 for 2.73V ...", not 2.37V as stated.

THE JOB MARKET

Gerry Kelly and Ted Wood investigate the claims and counter-claims about the growth of the British electronics industry and the jobs it will create, concentrating on Scotland in this article.

Scotland's growing microelectronics industry put another feather in its cap on 17 April this year. At a press reception held at the Scottish New Towns London Office, it was announced that EKC Technology Inc., which operates six manufacturing and distribution facilities in California's Silicon Valley, is to set up a plant in East Kilbride. East Kilbride is a growing new town and part of Scotland's attempt to be the California of Europe ('Silicon Glen' its promoters call it). Along with other Scottish new towns it has already attracted large amounts of foreign investment.

At the reception we were treated to a slide show and talk on the success story of East Kilbride, glossy brochures outlining its attractions to prospective investors, large amounts of food and drink and much heavy glad-handing from John Housley, EKC's Vice-President Marketing. On the way out we got an armful of freebies, including a miniature bottle of 'Spirit of East Kilbride' scotch.

The setting up of EKC's plant is undoubtedly important to both East Kilbride and the semiconductor industry in Scotland. The photoresist strippers they produce will contribute substantially to the infrastructure of the industry. As J. Allan Denholm, Chairman of East Kilbride Development Corporation, puts it: 'The decision by EKC to locate here confirms our role as Scotland's leading centre for overseas investment and adds a new dimension to our growing contribution to a Scottish production chain that goes all the way from raw silicon production to wafer fabrication, contract assembly, test and packing and printed board assembly.'

JOB TITLE	AVERAGE HOURLY WAGE£ (Exc. Shift and Overtime)	
General Production	**East Kilbride**	**Scotland**
Assembler	1.75	2.44
Assembler (senior)	1.85	2.65
Forklift Truck Driver	2.20	2.38
Goods-in Inspector	2.60	3.17
Grinding Machine Operator	3.00	2.45
Lathe Operator (Turner)	3.00	2.76
Machine Shop Inspector	3.25	2.58
Machine Tool Setter	3.20	2.75
Maintenance Electrician	2.50	3.08
Milling Machine Worker	3.30	2.48
Plant Labourer	2.00	2.40
Radial Drill Operator	2.30	2.42
Semi-Skilled Production Operator	2.10	2.85
Storeman	2.20	2.53
Tester	2.70	3.40
Toolmaker	3.20	2.90
Welder	3.20	3.14

Wage rates for unskilled and skilled workers in East Kilbride (figures from the East Kilbride Development Corporation, 1984).

The rub is that EKC's investment, an initial £1 million plus government grants (the amount of which John Housley was very reluctant to reveal) will produce only 25 jobs over two years, 'dependent on the marke

That seems to fit in with a general pattern of the British electronics industry. While seeing increased investment and output, it seems to be failing to create jobs on anything like the scale needed to replace those lost through the decline of traditional industries.

Awkward Questions

A week before the EKC reception a report was published which not only highlighted this problem but also asked some rather awkward questions about the electronics industry. The mention of its name at the Scottish New Town's London Office was about as welcome as Princess Michael's father at a Buckingham Palace garden party. The Scottish Development Agency was moved to issue a statement criticising it as ill-informed and misleading.

Published by Scottish Education and Action For Development, the report - entitled 'Electronics And Development: Scotland And Malaysia In The International Electronics Industry' - has little doubt that, in Scotland at least, 'the electronics industry cannot be expected to make a major contribution to meeting (the) future need for jobs.'

Scotland's electronics industry now employs around 43,000 people. In 1949 there were only 5,000. But as Scotland has lost 200,000 jobs in manufacturing and mining in the last decade, employment provided by the electronics industry will obviously not fill this massive gap. The SEAD report states that 'some experts believe that the industry will do well to increase its labour force by 7-8,000 by the end of the decade.'

The conclusion seems to be that the electronics industry, as it becomes more capital intensive and automated, will provide only a small increase in jobs. On a larger scale than EKC, National Semiconductor proposed a £100 million investment in Greenock, another of the 'Silicon Glen' towns. This has been postponed, but in any case would have created only 1,000 jobs. Motorola, the 'jewel in the crown' of East Kilbride, are investing £60 million in an automated assembly plant which will provide only 800 jobs.

This is all part of the general trend in British electronics. In a paper published in 1983 - entitled 'Policy for the UK Information Technology Industry' - the NEDC Information Technology Sector Working Party admitted that 'the UK employment implications of current trends in Information Technology are not encouraging. The overall decline in employment levels' said the paper, '.... is unlikely to be arrested.' The Sector Working Party's best hope was that the industry might contribute indirectly to the creation of new jobs in service industries.

Boom And Gloom

This gloomy prognosis is backed up by Luc Soete in the third volume of Gower Publishing's 'Technological Trends and Employment' series, *Electronics and Communications.*

'Despite the UK electronics industry's remarkable output growth pattern pointing directly to the significant of the sector as a "motor" for the economic recovery, first estimates of employment suggest that this boom has been accompanied with little employment creation.'

While Soete concludes that the potential for job creation is still considerable, taking the 'optimistic scenario', the growth in electronics employment does not compensate for the loss of jobs in the rest of engineering. The respective figures are +70,000 and —81,000. The 'pessimistic scenario' sees employment in the rest of engineering as declining by more than 350,000 by 1990, while the compensation in increased electronics jobs is only 15,000. The NEDC Sector Working Party's paper agrees with a pessimistic forecast of a decline in employment in the UK IT manufacturing industry.

Any estimate has to assume an ability on the part of the electronics industry in Britain to combat foreign competition. According to Luc Soete, 'it is still debatable how far import penetration or fiercer competition on the UK export markets could curb the UK Industry's growth potential and press towards a speedier introduction of labour saving rationalisation investment.' The NEDC paper says that although the UK IT industry has strengths, 'these strengths in isolation are not however sufficient; they need to be brought together not least by industry itself into a national policy if the industry is to prosper.'

In the IT sector, UK companies have a minority share in most of the UK's markets while foreign-owned multinationals have the majority. The British companies are structurally weak in comparison with their foreign competitors and there seems little chance that their performance will improve drastically. According to the NEDC SWP, the target for the UK IT industry, as part of a national policy, should be to break even on balance of trade by 1990. A modest enough goal.

In Scotland, by the Scottish Development Agency's own reckoning, Scottish owned firms account for only 16.5% of employment in the electronics industry. The semiconductor industry is wholly foreign-owned, with five US firms providing 90% of the jobs and one Japanese company supplying the other 10%. Leading US firms also figure prominently in the information systems sector in Scotland (including IBM, DEC, Honeywell, Burroughs and Wang) though new Scottish-based firms have emerged here. Meanwhile, Scottish Education and Action for Development argue that the 'complete dependence of Scotland's semiconductor industry on a small number of companies.... has prompted fears for the long term future of the industry in Scotland.'

All Work And No Pay?

But whatever the arguments about the *long term* prospects for employment creation in electronics, in the short term jobs themselves don't seem to be the priority. One of the attractions East Kilbride offers investors is wage rates significantly lower than in the rest of Scotland (see Table). Where comparatively good rates operate, this is due to one fact alone: 'the biggest union in the town is the Amalgamated Union Of Engineering Workers.' (Note that assemblers are mainly women). The Scottish New Towns as a whole boast of a low level of unionisation and generally 'trouble free' factories.

Many of the US companies in Scotland have a record of anti-unionism. Having resisted unions' attempts to organise in 'Silicon Valley', they are hardly likely to welcome them in 'Silicon Glen'.

When asked about this, John Housley of EKC commented that, although company policy was not anti-union, EKC in the States is non-union because 'none of our employees have expressed the desire to join.' He followed this with the ambiguous assertion that companies who got the union in, generally deserved it. Significantly union membership is also particularly low among electronics workers in the London-Bristol corridor.

While some would argue that any employment is good employment, the quality and conditions of work should also matter. More often than not these things are determined by the presence of trade union organisation. This, at least, is the view held by Scottish Education for Action and Development:

'In the most practical terms the absence of trade unions leaves the workers vulnerable to company pressure to fit in with changes in working practices, such as new shift arrangements or short-term contracts. It may make them frightened to speak up on health hazards for fear of losing their jobs. In periods of recession it leaves them dangerously exposed to the company's need to adjust it's costs.' For some, however, such considerisations are secondary. 'Speaking personally,' said Alistair Dalziel, of the East Kilbride Development Corporation, 'I don't think it matters'. He was replying to our questioning the amount of employment the Scottish eletronics industry is creating. 'It's the investment that matters.'

ETI

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THE NUMBER JUNGLE

A lot of people have written to us asking for an explanation of the numbering systems used on ICs and other semiconductors. John Linsley Hood, something of an expert on components as his continuing series proves, has put together the following guide.

Integrated circuits are the easy route to circuit design, since many clever engineers have thought out neat ways of achieving the desired end, in conveniently packaged and often quite inexpensive circuit blocks. However, there are two main snags. The first of these is knowing which is the right IC to use, and the second, when this problem has been solved, is to decide which version of the IC in question is the device one wants.

The circuit diagram may show a 741, but the catalogue lists a whole range of these from MC1741SCG to LM1741CJ-14. What does this mean? And the problem doesn't stop there, there are all the digital ICs too.

Prefix	Manufacturer
AD	Analog Devices
AM	Advanced Micro Devices
CA	R.C.A.
DS, LM, LF, LH	National Semiconductor
DG	Siliconix
H, HA, HI	Harris
HA	Hitachi
ICL, ICM	Intersil
IR	International Rectifier
MC	Motorola
OP, PM	Precision Monolithics
N, NE, SE	Signetics (Mullard)
RC, RM	Raytheon
SG	Silicon General
SL, SP	Plessey
SN, TL	Texas Instruments
µA	Fairchild
UCN, UDN, ULN	Sprague
XR	Exar
Z, ZD	Ferranti

Table 1 The codes used in the manufacturers prefix. These form the first group of letters in an IC type number, appearing before the number itself.

Suffix	Temperature range
1 (Harris only)	−55°C to +200°C
M (2 for Harris, 54 for TTL)	−55°C to +125°C
I	−25°C to +85°C
C (5 for Harris, 74 for TTL)	0°C to 70°C

Table 2 Permitted temperature range. One of these letters (or numbers in the case of Harris ICs and TTL) will usually appear immediately after the IC number.

Well, to start with, the first two letters in the specification refer to the maker of the device. MC, for example, refers to Motorola, µA to Fairchild, and so on. The letters at the end of the specification refer to the packaging, the temperature range for permitted operation, or the reliability guarantee. Here C stands for commercial (0°C to 70°C) and M for military (-55°C to +125°C), which will be a whole lot more expensive. Say £15 for the military version, as compared with 40p for the plastic encapsulated commercial device.

Transistor type designations are a good bit simpler since they do not usually have a prefix identifying the maker or a suffix specifying one of a range of package forms. The package is usually implied by the actual type number of the transistor. Unless they are very popular devices, like a BC109 or a BC212, a particular transistor will only be available from one or maybe two manufacturers.

The BC type designation is, incidentally, a european Pro Electron designation, which actually gives a description of the general type of the device in its letters. The USA JEDEC listing, 1N-, 2N- and 3N-, only refers to the time at which that particular device was registered with the US military authorities, so a 2N5068 is a much more recent device than a 2N697.

There is, however, a small measure of type identification in that 1N- means diodes, 2N- means bipolar or junction field-effect transistors and 3N- means MOSFETS. United States sourced transistors (and ICs) are usually second-sourced (which means that there are at least two manufacturers), whereas the Pro Electron devices may come from one manufacturer alone. This is awkward if some inconsiderate designer (like me) specifies a favourite device such as a Motorola BC449 which is probably not stocked by Bloggs Radio just round the corner, though they could have supplied a BF257 which might, at a pinch, have done the same job.

The letters at the end of the transistor type number, for small signal devices, usually denote the

Manufacturer	Metal can	Plastic DIL			Ceramic DIL			Power plastic	
	TO99 TO100 8 pin 10pin	8 pin	14 pin	16 pin	8 pin	14 pin	16 pin	TO92	TO220
Advanced Micro Devices		P	P	P	D	D	D		
Analog Devices	J								
Fairchild	H	T	P	P	R	D	D	W	U
Intersil	K								
ITT		N	N	N	D,J	D,J	D,J		
Harris (H, HA, HI)	2*	3*	3*	3*	1*	1*	1*		
Motorola	H,G	P	P	P	V	L	L	P	T
National Semiconductor	H,G	N	N	N	J	J	J	Z	T
Precision Monolithics	J	P	P	P	Z	Y	Q		
Raytheon	H	DN	DB	MP	DE	DC	DD	S	U
Signetics	H	N,V,N,E	F,A,N,H	B,NJ	FE	FH	FJ		
Siliconix	A	J	J	J	K	K	K		
Sprague	H	M	A	A	H	H	H	Y	Z
R.C.A	T								
Texas Instruments	H	P	N	N	JG	J	J	LP	KC
	mainly linear ICs	mainly commercial or industrial types			mainly military or industrial types			transistor types	

Table 3 IC package description. One or more letters will usually be placed immediately after the temperature code letter, except in the case of Harris ICs where numbers are used (marked with an asterisk) and placed before the type number.

current gain range or the pin configuration.

In digital ICs, the device classification, if it isn't bog-standard TTL or CMOS, is tucked into the middle of the part number. The LS in 74LS68 indicates a low power Schottky device, for example, while the HC in 74HC160 stands for high speed CMOS.

As a general rule, plastic encapsulations are cheaper than metal can or ceramic dual-in-line packages, and commercial temperature range devices are cheaper than the industrial or military versions of the same. Although I have my favourite brands (often those manufacturers whose data books are more solidly represented on my office book shelves or whose distributors I happen to have a trade account with), my experience is that most modern devices from Western Europe, Japan or the United States (and this must include such 'off-shore' factory sites as Taiwan or San Salvador) are reliable in performance and packaging — the companies in question would have gone bust in this competitive age if this were not the case.

Finally, while there are very few magic differences between one device and another for a given voltage, power and current range — an NPN small signal transistor tends to be much about the same as another NPN small-signal transistor — nevertheless it is fairer to the designer if you try to use the particular device specified — there may be good reasons for the choice. For my part, as a designer, I will try to identify in future designs which are the critical devices and which ones could, in all probability, be substituted without any great effect on performance.

ETI

Family type	Description	Propagation delay (per gate)	Average Power (per gate)
74 ALS . .	Advanced Low-power Schottky	3-4ns	1-2mW
74 LS . .	Low-power Schottky	10ns	2mW
74 . .	Standard TTL	10ns	10mW
74 S . .	Schottky TTL	3ns	20mW
74 L . .	Low-power TTL	33ns	1mW
74 C or CD	CMOS	50ns	<1μW

Table 4 The letter codes used in the middle of 7400 series TTL type numbers to indicate the technology used.

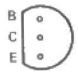
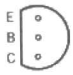
First letter	Second letter	Third letter (if any)	Number	Final letters
A = germanium	A = small signal diode			lead-out arrangement:- (Pin view)
B = silicon	B = varicap or rectifier diode			
C = gallium arsenide	C = small signal transistor			
	D = power transistor	not usually significant	manufacturers catalogue number	
	E = point contact diode			L = 
	F G = high frequency transistor L			
	R = special purpose device			NO LETTER = 
	S = switching diode or transistor			
	T = thyristor or triac			
	U = high voltage transistor			current gain at 1mA:-
	X = same as B			A = 40 – 120
	Y = power rectifier			B = 150 – 460
	Z = zener diode			C = 270 – 800

Table 5 The European Pro Electron classification system used to identify discrete semi-conductors.

PRINTER BUFFER

Have you ever waited twenty minutes for your computer to print the program listing for your latest hyper-space mega-adventure game? This project won't make the printer run any faster, but it will stop the computer being tied up for the whole time and let you get on with your programming. Design by Nick Sawyer.

The printer buffer is designed to appear to the computer as an ultra high speed printer, with up to 48K of memory and capable of accepting data at a rate of several kilobytes per second. This data is then passed on to the printer at the much slower rate required, about several tens of bytes per second. As the unit appears to the micro as a printer with a standard Centronics interface, it is not specific to any one type of computer, and can be used with any system having a Centronics - type facility.

The buffer has been designed to be flexible in the amount of memory that can be fitted. It can contain either 16, 32 or 48K of memory, so you can start with 16K and upgrade at any stage simply by plugging in more dynamic RAM chips. The software contained in a pre-programmed 2176 EPROM looks after the complicated aspects, and if you feel that you need more than 48K of memory then merely put two or more complete units in series. Remember though, that 48K is about 15 A4 pages of BASIC listing, which should be more than enough for home use.

The buffer features a comprehensive push-button initiated self and RAM test, with printed results. An abort buton is also provided for completely re-setting the buffer and its memory.

What is a Centronics - type interface? It is basically a method for transferring data in seven or eight bit wide chunks from one device to another, and includes a 'handshake' mechanism to control the speed of transfer. The sequence of events is shown in Fig.1.

Valid data is set up on the parallel data lines and the STROBE line is then pulled low by the transmitting device (computer). The receiving device (printer) responds by pulling the BUSY line high for as long as is necessary to process the data received. The BUSY line is then pulled back low and a short 'active low' pulse is output on the ACK line to indicate that the transfer is complete and the next data byte may be transmitted. The busy period may be anything up to one second during carriage return on a slow printer, and the transmitting computer is normally idle during this time.

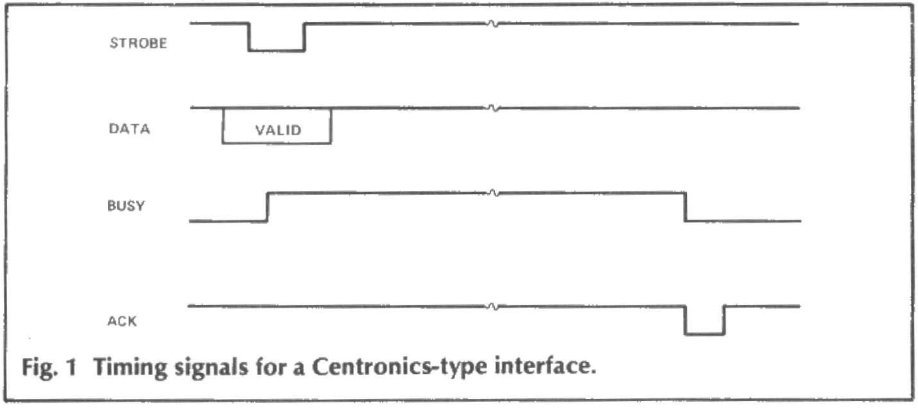
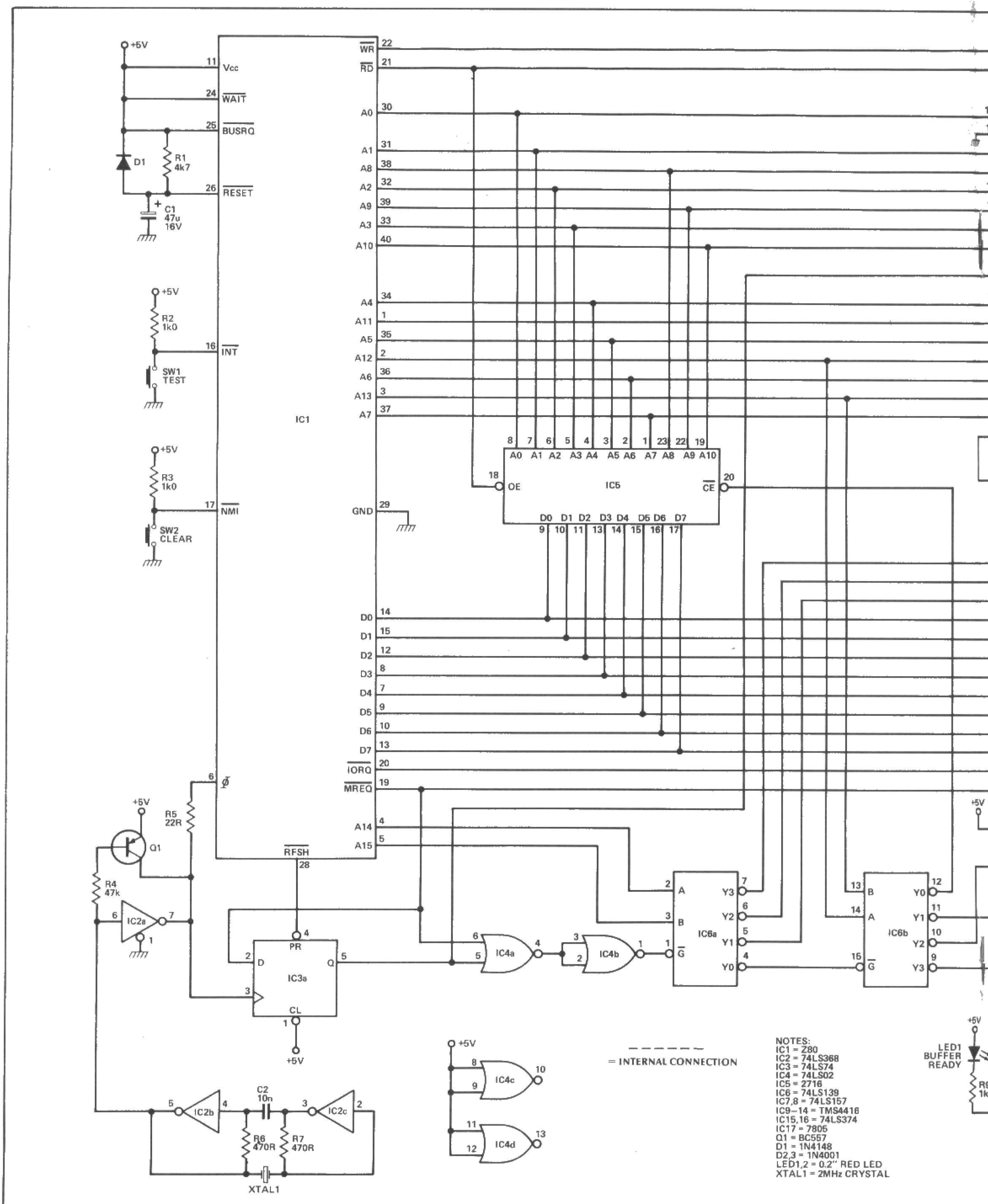


Fig. 1 Timing signals for a Centronics-type interface.

Construction

The printer buffer is built on a double sided board without plated through holes for reasons of cost. This means that where tracks are joined to components on both sides of the PCB, they will need to be soldered to the component on each side of the board. This presents no problem so long as it is remembered to leave components, IC sockets in particular, standing slightly proud so as to allow access for a thin-tipped soldering iron. In addition there are several connections which will need to be made through the board using either pins or bits of wire, again soldered on each side.

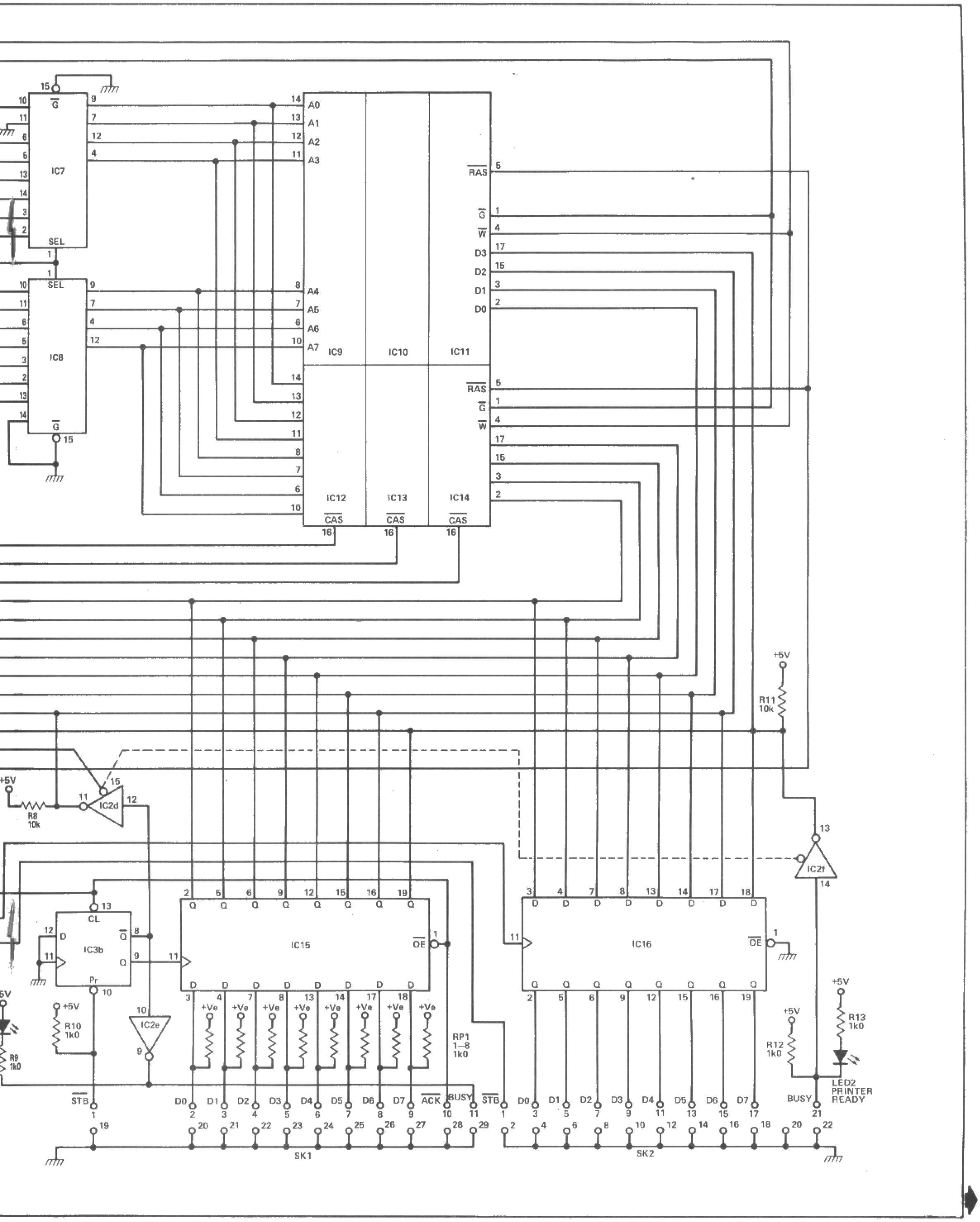
Sockets should be used for the microprocessor IC1, the EPROM IC5, and the six dynamic RAM chips IC9-14. All remaining ICs and the other components may be soldered straight in, taking care not to overheat them.



NOTES:
IC1 = Z80
IC2 = 74LS368
IC3 = 74LS74
IC4 = 74LS02
IC5 = 2716
IC6 = 74LS139
IC7,8 = 74LS157
IC9–14 = TMS4416
IC15,16 = 74LS374
IC17 = 7805
Q1 = BC557
D1 = 1N4148
D2,3 = 1N4001
LED1,2 = 0.2" RED LED
XTAL1 = 2MHz CRYSTAL

– – – – – – = INTERNAL CONNECTION

Fig. 2 The circuit diagram of the printer buffer.


IC7
IC8
SEL
G
IC9
IC10
IC11
IC12
IC13
IC14
A0
A1
A2
A3
A4
A5
A6
A7
RAS
W
D3
D2
D1
D0
CAS
+5V
R11
10k
R8
10k
IC2d
IC2f
IC2e
IC3b
CL
D
Q
Pr
R10
1k0
R9
1k0
IC15
OE
IC16
+Ve
RP1
1–8
1k0
+5V
R12
1k0
R13
1k0
LED2
PRINTER
READY
STB
D0
D1
D2
D3
D4
D5
D6
D7
ACK
BUSY
STB
BUSY
SK1
SK2

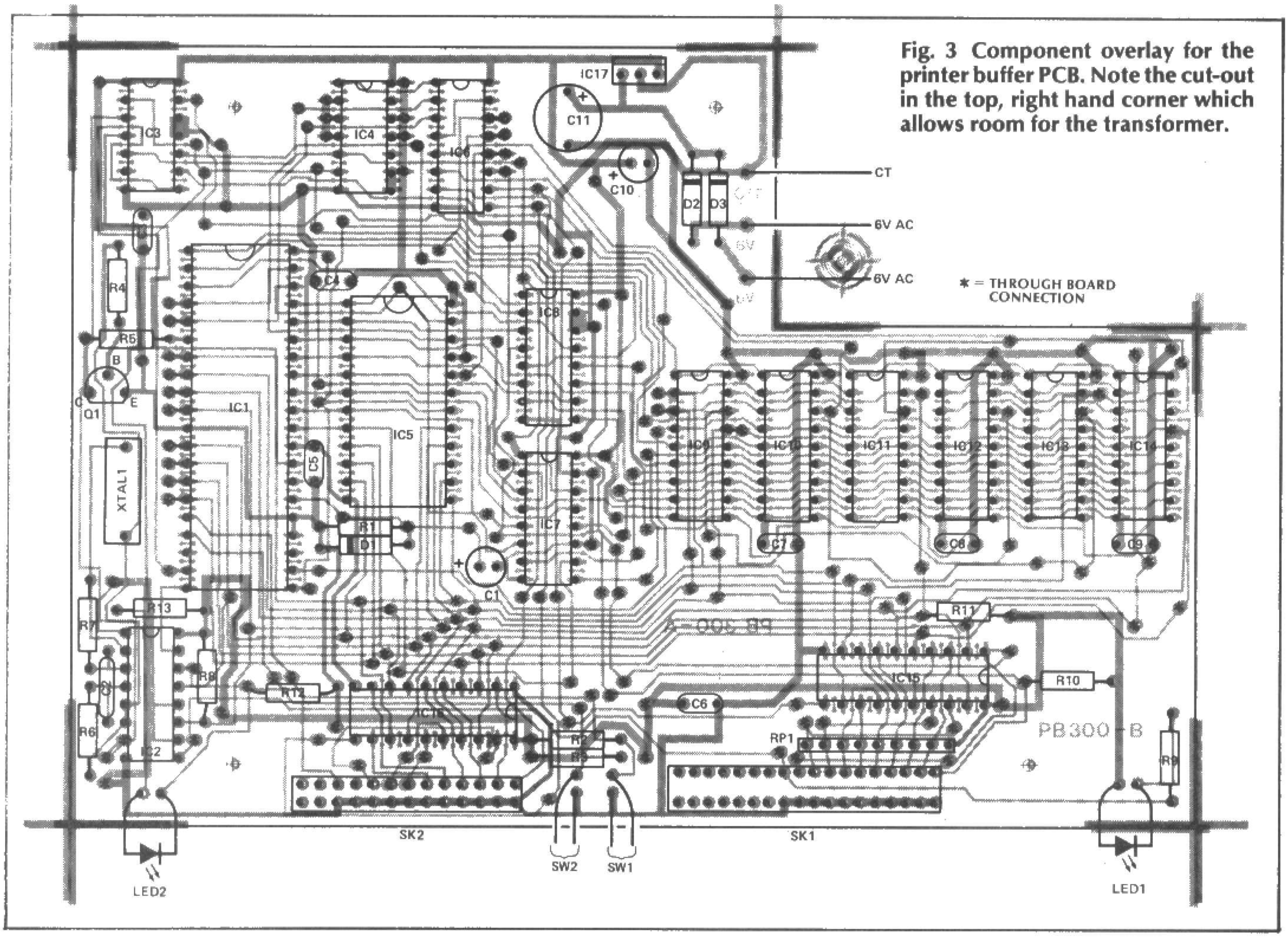


Fig. 3 Component overlay for the printer buffer PCB. Note the cut-out in the top, right hand corner which allows room for the transformer.

PARTS LIST

RESISTORS (¼W, 5% unless otherwise stated)

R1	4k7
R2,3,9,10,12,13	1k0
R4	47k
R5	22 R ½W
R6, 7	470 R
R8, 11	10k
RP1	1k0 x 8 SIL resistor pack

CAPACITORS

C1, 10	47u, 16V electrolytic
C2	10n ceramic
C3-9	100n ceramic
C11	2200u, 16V electrolytic

SEMICONDUCTORS

IC1	Z80
IC2	74LS368
IC3	74LS74
IC4	74LS02
IC5	2716
IC6	74LS139
IC7, 8	74LS157
IC9-14	TMS4416
IC15, 16	74LS374
IC17	7805
Q1	BC557
D1	1N4148
D2, 3	1N4001
LED1, 2	0.2" Red LED with panel-mounting holder

MISCELLANEOUS

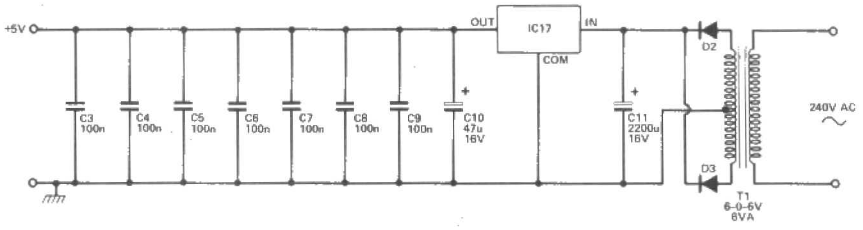
SK1	36 way right angle Centronics-type PCB mounting socket
SK2	26 way IDC plug
SW1, 2	momentary action push-to-make switches, panel mounting
T1	6-0-6V, 6VA chassis mounting transformer
XTAL1	2MHz crystal

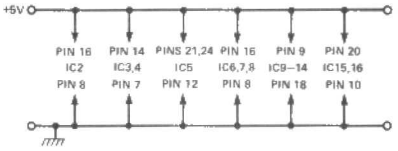
PCB; 26 way ribbon cable; DIL IC sockets, 6 off 18 pin, 1 off 24 pin and 1 off 40 pin; plastic case 250 x 140 x 75mm; nuts bolts, wire etc.

BUYLINES

All of the semiconductors and the other general components are widely available from companies advertising in these pages. The box in which the prototype is housed is a Verocase, number 202 - 21035, and is available from Electrovalue, Maplin and TK Electronics among others. The right-angle 36 way Centronics connector is an RS Components part, catalogue number 470-639. RS will only handle orders from trade and professional customers, but if you are unable to use them because of this you can obtain the part through Crewe Allan & Co of 51 Scrutton Street, London EC2 on payment of a small handling charge. A pre-programmed EPROM is available from Tronik Designs, 68A Broomfield Avenue, Palmers Green, London N13 4JP, and costs £7.85 inclusive. Please allow 10 days for delivery. A double-sided PCB is available from the same address for £10.75 and 28 days should be allowed for delivery. Please note that the PCB will not be available through our own PCB Service.

HOW IT WORKS





At the heart of the circuit is a Z80 microprocessor (IC1) running at 2MHz. The single phase 2MHz clock is provided by a simple crystal controlled oscillator using three LSTTL inverters (part of IC2), and a pull up transistor to provide the non-standard clock levels required by the Z80. Power-on reset for the microprocessor is provided via an RC network with a time constant of around 200 ms. The diode D1 is provided to ensure a reset occurs should the power supply fail momentarily.

The two function switches, test and abort are connected to the two active-low interrupt inputs of the Z80, INT and NMI respectively. The inputs are normally connected to 5 volts via a resistor and are grounded if a switch is pressed, causing an interrupt which is processed by the software. The software itself is carried in a 2716 EPROM (IC5) which is a 2Kx8 device requiring eleven address lines. An active-low decode from the address decoder is connected to the chip select line of the 2716, and this is used in conjunction with the RD line to gate data from the EPROM onto the data bus for addresses 0000 to 0FFF Hex. In fact only addresses up to 07FFh are used as these are sufficient to decode 2KBytes.

Address decoding is performed by two halves of a 74LS139 dual two to four line decoder, IC6a&b. IC6a decodes address lines A14 and A15 to give four segments of 16K each. The lowest of these segments is further decoded using address lines A12 and A13 to give four segments of 4K each. This therefore gives the addressing capability shown in the memory map.

The possible 48K of RAM is made up from six TMS4416 dynamic RAM IC's, each of which is organised as 16Kx4 bits. This means that two devices are needed to make each 16K segment. In common with most types of dynamic RAM, the required fourteen address bits have to be multiplexed onto eight lines. This is done to keep the package size down. Eight address bits are strobed into the IC's by a falling edge on RAS (Row Address Strobe), and the remaining six bits are strobed in by a falling edge on CAS (Column Address Strobe).

These strobe signals are generated by a combination of the signals MREQ, RFSH, and the 2MHz clock signal. The signal MREQ is connected directly to the RAS lines of all the RAM chips, so that an address is strobed in each time MREQ goes low. This will occur on two occasions, when the micro is requesting data from memory and when an automatic refresh cycle is being performed by the Z80. These refresh cycles are necessary for proper operation of the dynamic RAMs. When the micro is requesting data from the memory, the RFSH line will be high and a delayed version of MREQ will be clocked into the flip-flop IC3a by the clock signal. The Q output of the flip-flop is used to switch the two adress multiplexer chips, IC7&8, and also to enable the address decoder IC6a. The NOR gates, IC4, are present to provide some delay for this signal and also ensure that it goes back high at the same time as the MREQ. The signal used for CAS is the appropriate output of the address decoder and this will latch the second half of the device address into the DRAMs. In case of a refresh cycle, the signal RFSH will go low and prevent the signal MREQ being clocked into IC3a, so preventing the above procedure but ensuring that the refresh requirement of the dynamic RAMs is met.

The pins G and W on the RAMs are connected to RD and WR respectively and these control the direction of information for both read and write cycles. The data pins are connected directly to the data bus of the Z80 as no buffering is needed.

The two 74LS374s hold the information for transfer to and from the outside world. Data is presented from the computer at the D inputs of IC15. When the STB line from the computer goes low it causes the Q output of the flip-flop IC3b to go high. This is connected to the clock line of IC15 and so data is strobed into its latches. The Q bar output of IC3b is also fed back to the Z80 via a tri-state buffer IC2d, and this informs the software that data has been received. This line is also fed back to the transmitting computer via an inverter IC2e thus serving as the BUSY line. The state of this line is shown by LED1, which will illuminate when the line is low to indicate buffer ready.

When the Z80 reads the latches in IC15, the read strobe generated is also used to clear IC3b thus removing the BUSY signal, and is also fed back to the transmitting computer to serve as the ACK signal. The above procedure is repeated until the transmitting computer has no more data or the buffer runs out of space, in which case the buffer will keep the computer waiting until space becomes available as data is output to the printer.

Data to be output to the printer is written by the Z80 into the octal latch IC16, the outputs of this latch being fed to the data inputs of the printer. The Z80 monitors the BUSY line of the printer by enabling, with IORQ, the tri-state buffer IC2f, and when it discovers that the printer is no longer busy the STB line is pulled low for a few microseconds. This strobes data into the printer which will then go BUSY again. This sequence is repeated until the buffer has been emptied. It should be mentioned that the input and output processes take place simultaneously, the software being in control at all times. The state of the printer busy line is also shown by LED2, which will illuminate when the printer BUSY line is low to show that the printer is ready.

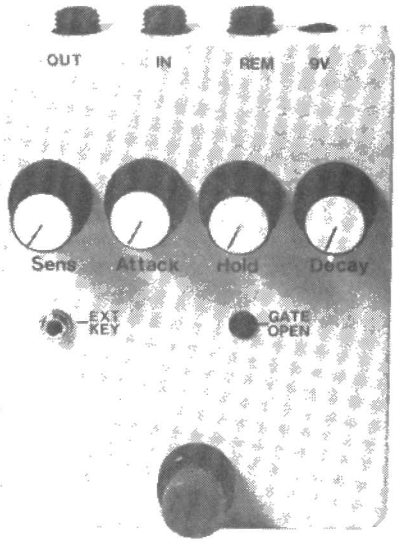
The power supply is quite straightforward, consisting of a centre-tapped transformer whose output is rectified and smoothed by D2 & 3 and C11. The resulting DC is fed to the voltage regulator IC17, which maintains a constant output of 5 volts. Capacitor C10 is provided for further smoothing, and capacitors 3 to 9 are for de-coupling.

Testing, Connection and use of the printer buffer will be described in a concluding article which we hope to publish next month, along with a complete listing for those diehards who prefer to program their own EPROMs!

ETI

NOISE GATE

There are those who say they can't tell the difference between the music and the noise these days, but Ian Coughlan's versatile unit is not so easily fooled. And when it's not opening up the way to noise-free music, you can use it as an envelope shaper.



Every musician knows the problems caused by noisy leads and effect-units: whenever you stop playing, the snaps, crackles and pops are still there. This state of affairs is acceptable when practising, but is a major headache when recording or playing live. One solution is a noise-gate, the electronic equivalent of pulling the jack-plugs out every time you stop playing. Needless to say, the noise-gate does it so unobtrusively that you'd never know it was there, which is the whole idea!

Important parameters of a good noise-gate are:

Threshold: this is the input signal level required to open the gate, and is adjustable from -35dBm down to -65dBm approximately. Normally it will be set just above the noise-floor, so that when playing begins, the increase in signal-level is sufficient to open the gate.

Response time: this is the time taken for the noise-gate to begin opening once the threshold has been crossed (some manufacturers of noise-gates call this the attack-time, which is not strictly correct. Ideally it should be instantaneous, and in practice should be less than a millisecond and not adjustable.

Attack-time: this is the time the gate takes to go from fully closed to fully open. Most noise-gates open instantly, which is what is usually required. This design will do so if you want it to, but can also be adjusted to take up to 100ms to open.

Hold-time: this is the period for which the noise-gate remains fully open after playing has stopped. It is adjustable between 100ms and 2s.

Decay-time; this is the time taken for the noise gate to close after the Hold-time has elapsed. This is really what sets this design apart from others: it will reach the fully closed state within 100ms if you want, but it can also be set to take as long as two seconds, causing any noise to go away unobtrusively rather than abruptly.

As well as being triggered by the incoming signal, the noise-gate may also be opened by another signal connected to the EXT. KEY socket, by a logic level on the REM socket, by a switch contact (also on the REM socket), or by the built-in footswitch. Whichever triggering method is used, the attack, hold, and decay controls still function. Because the envelope shape is completely adjustable and the unit can be controlled by a variety of inputs, it can be used as an envelope shaper in its own right.

Construction

Before soldering anything into place, check that your PCB has a hole under PR1 and, if not, carefully drill a ¼" hole there. This will allow the preset to be adjusted from the underside of the board when the unit is assembled into its case. When the bare board is ready, commence assembly by installing the wire link, the four

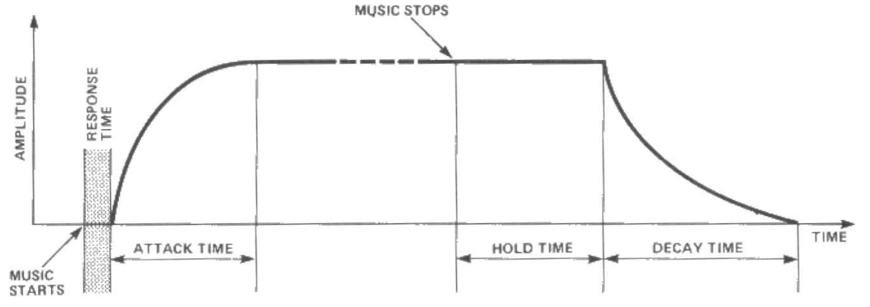


Fig. 1 The response envelope produced by the noise gate.

The gate is IC2, a transconductance amplifier whose gain is controlled by the current flowing into pin 5. The two halves of IC1 are connected as unity gain buffers, one before and one after the transconductance amplifier. The gain of the transconductance amplifier is adjusted to unity by PR1, so the overall gain of the audio path is also unity when the gate is open.

The threshold detector consists of IC3d and the two halves of IC4. The input is taken either from the main audio path, immediately after the buffer stage IC1a, or from the EXT. KEY socket. R15 and C9 form a low-pass filter which removes RF noise and the signal is then passed to the amplifier stage IC4a whose gain is set by the sensitivity control. This is followed by a fixed gain stage, IC4b, which ensures that sufficient level is available to reach the threshold of the comparator.

The window comparator is based around IC4d and is slightly unusual in using only one op-amp. When the output from IC4b is of sufficient amplitude, it will push pin 2 of IC3d higher than pin 3 via D5, or pull pin 3 lower than pin 2 via D4. Provided the gate is not in the bypass mode, pin 5 of the NAND Schmitt trigger IC5a will be at a logic high level and the stream of negative going pulses from the output

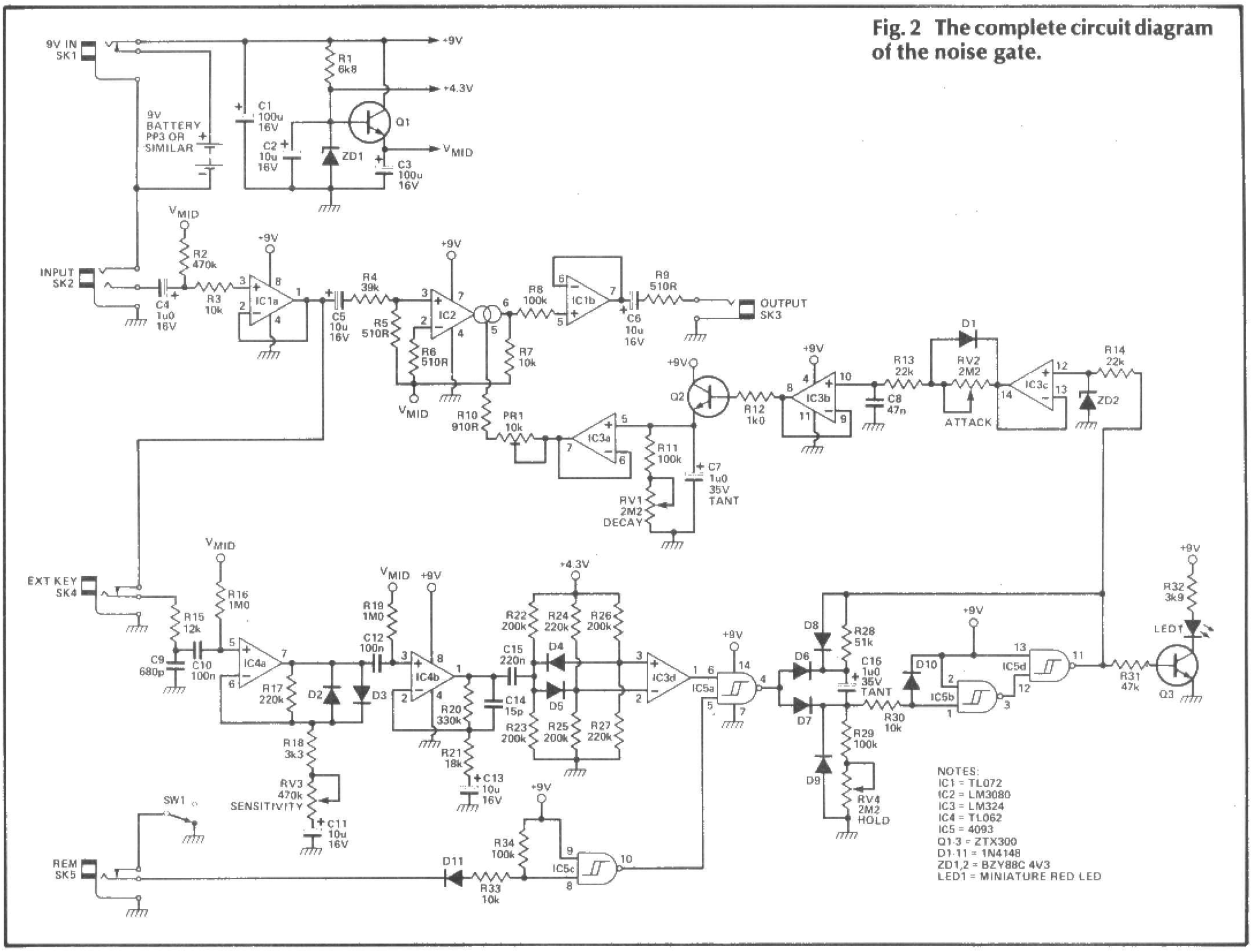


Fig. 2 The complete circuit diagram of the noise gate.

NOTES:
IC1 = TL072
IC2 = LM3080
IC3 = LM324
IC4 = TL062
IC5 = 4093
Q1-3 = ZTX300
D1-11 = 1N4148
ZD1,2 = BZY88C 4V3
LED1 = MINIATURE RED LED

HOW IT WORKS

of IC3d will produce positive going pulses on pin 4 of the Schmitt.

As long as these pulses are present, diodes D6 and D7 will conduct and hold the two ends of C16 at the same potential, preventing it from charging. IC5b and IC5d both have one input connected to the positive supply and will thus act as Schmitt inverters. Pin 1 of IC5b will be held high via R30 causing its output to stay low, and this low appearing on pin 12 of IC5d will force pin 11 high.

When the pulses at the output of IC5a cease, D6 and D7 will no longer conduct and C16 will begin to charge via D8 from the logic high on IC5d's output. The rate of charging will be determined by the setting of RV4. As the voltage across the capacitor rises, the voltage across R29 and RV4 will fall and pin 1 of IC5b will be pulled low via R30. At a point determined by the operation of the Schmitt, IC5b will change state, its output going high and switching IC5d whose output will go low. Since it was the voltage from this gate which charged the capacitor, no further charging can now take place and the circuit will remain in this state until a further train of pulses is received from IC3d and IC5a.

If bypass mode is selected either by operation of SW1 or by means of a logic signal into SK5, IC5a pin 5 will be held low via the Schmitt inverter IC5c. This will cause IC5a pin 4 to remain high, whereupon D6 and D7 will conduct, IC5b pin 1 will be held high via R30 causing pin 3 to go low, and the resulting low on pin 12 of IC5d will cause pin 11 to remain high. This pin will then stay high for as long as the unit is in the bypass mode.

This high level drives the GATE OPEN LED via Q3 and R31, R32 and also provides a voltage into pin 12 of IC3c. This voltage is held down to 4.3V by ZD2 and R14. IC3c is a unity gain buffer stage which, on receiving an input volage, charges C8 via R13 and RV2. The time taken to charge C8 is the attack time and is adjusted by RV2. The voltage on this capacitor is buffered in turn by IC3d and used to drive Q2 which then charges C7. The voltage across this capacitor corresponds to the decay portion of the envelope shape and the discharge period is adjusted by RV1. IC3a is another unity gain buffer which couples the composite envelope shape voltage to the gain-determining pin of the transconductance amplifier, IC2. PR1 allows the overall gain of the audio path to be adjusted back to unity.

The complete circuit operates as follows. When the input signal exceeds the threshold, pulses will be produced at pin 1 of IC3d in the manner previously described. Just one of these pulses is sufficient to send IC5d pin 11 high with no apparent delay and this in turn produces 4.3V at pin 14 of IC3c. IC3b pin 8 will also rise to 4.3V but will do so exponetially because of the action of C8, R13 and RV2. C7 is much larger than C8 but it will charge at the same rate because it is fed from the low resistance source provided by the emitter follower Q2. As the voltage on this capacitor rises, so will the current flowing into pin 5 of IC2 and so the gain will increase.

When the input signal falls below the threshold, the pulses on IC3d pin will cease and pin 11 of IC5d will go low after a period of time determined by the setting of RV4. The output of IC3c will then also go low and C8 will discharge through R13 and D1. C7 will also discharge but at a rate determined by the setting of RV1. This falling voltage will reduce the current flowing into pin 5 of IC2 and hence the gain of the audio path will fall.

Most of the circuit operates directly from the 0V and +9V supply, but some parts of it require a centre tap to provide something approaching dual-rail operation. This intermediate voltage is provided by ZD1 and Q1.

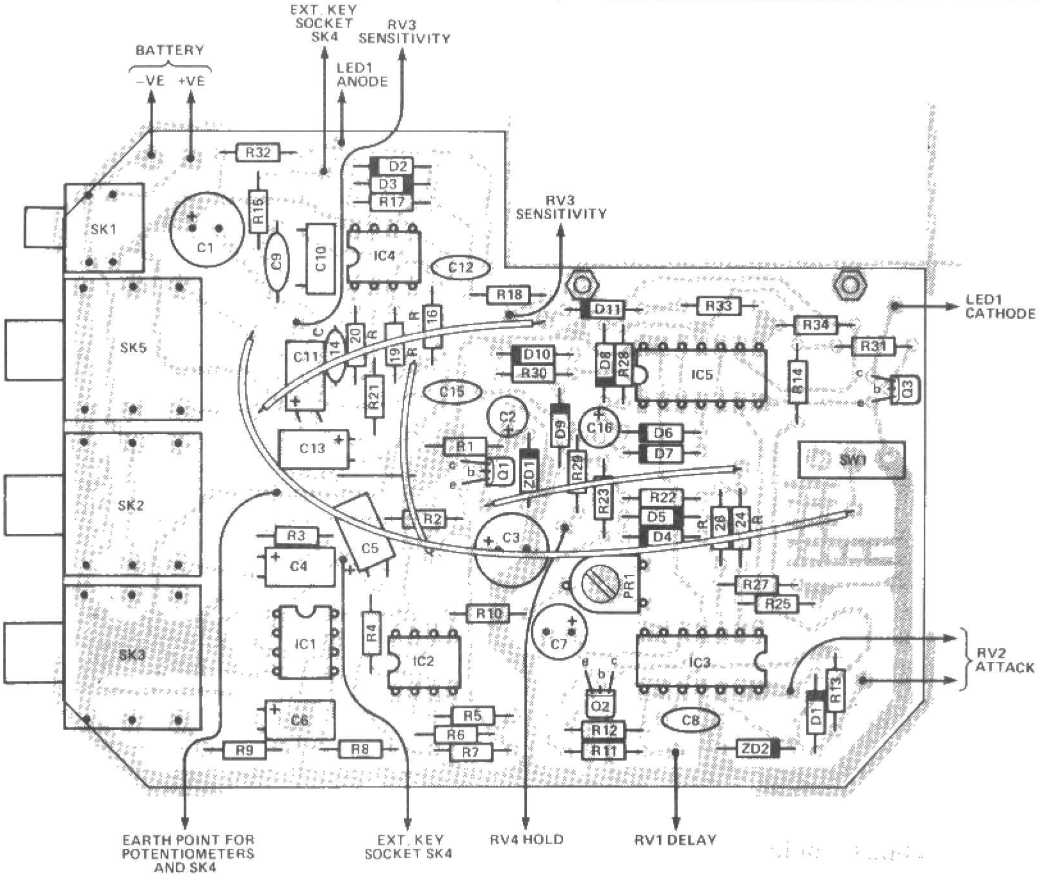


Fig. 3 The component overlay for the noise gate PCB. Note the use of insulated wire links across the board and that the capacitors at the socket end are laid flat to prevent their interfering with the potentiometers when the case is assembled.

PARTS LIST

RESISTORS (all ¼W, 5% unless otherwise stated)

R1	6k8
R2	470k
R3, 7, 30, 33	10k
R4	39k
R5, 6, 9	510R
R8, 11, 29, 34	100k
R10	910R
R12	1k0
R13, 14	22k
R15	12k
R16, 19	1M0
R17, 24, 27	220k 2%
R18	3k3 2%
R20	330k
R21	18k
R22, 23, 25, 26	200k 2%
R28	51k
R31	47k
R32	3k9
RV1, 2, 4	2M2 logarithmic
RV3	470k logarithmic
PR1	10k horizontal skeleton preset

CAPACITOR S

C1, 3	100u 16V radial electrolytic
C2, 5, 6, 11, 13	10u 16V radial electrolytic
C4	1u0 16V radial electrolytic
C7, 16	1u0 35V tantalum bead
C8	47n multi-layer
C9	680p polystyrene
C10, 12	100n multi-layer
C14	15p polystyrene
C15	220n multi-layer

SEMICONDUCTORS

IC1	TL072
IC2	LM3080
IC3	LM324
IC4	TL062
IC5	4093
Q1-3	ZTX300
D1-11	1N4148
ZD1, 2	BZY88C 4V3
LED1	miniature red LED with mounting bezel

MISCELLANEOUS

SK1	3.5mm miniature jack socket, PC mounting, with switch
SK2	¼″ stereo jack socket, PC mounting, with switch
SK3	¼″ mono jack socket, PC mounting
SK4	3.5mm miniature jack socket, panel mounting, with switch
SK5	¼″ mono jack socket, PC mounting, with switch
SW1	SPDT alternate action push switch, panel mounting

PCB; case; knobs, 4 off; battery connector; ¾″ (20mm) high mounting pillars, 2 off and screws or bolts to suit; 14-pin DIL IC sockets, 2 off; thin foam rubber; 9V battery, PP3 or similar.

BUYLINES

The ¼″ jack sockets used in the prototype are made by Cliff and are designed for PCB mounting. They are not readily available in small quantities but their pin spacing is the same as that of Cliff's panel mounting ¼″ jack sockets which are available from Electrovalue. The panel mounting type have solder tags with eyelets rather than pins, but it is a simple matter to cut away one side of the eyelet so as to leave a pin narrow enough to suit the holes in the PCB. Other makes of jack socket available from other suppliers may also be suitable if so modified but we have not tried this.

The potentiometers used are also supplied by Electrovalue and are from their P20 range. RS components stock a suitable switch (catalogue number 339-241) and a 15mm button for it (catalogue number 339-279 for a pack of three) but they do not stock a shroud as used on the prototype. A switch with a shroud is available from Electromatch for £4.15 including post and packing. The part numbers are MPA106D for the switch, C23 for the button and G13 for the shroud and you can contact them on 0403 - 814111 to obtain up-to-date ordering information. The box is made by STC and is type number 73399B. It costs £1.97 plus VAT but inclusive of post and packing from STC Electronic Services Ltd, Edinburgh Way, Harlow, Essex CM20 2DF. All of the other components are available from our regular advertisers and the PCB is available from our PCB Service.

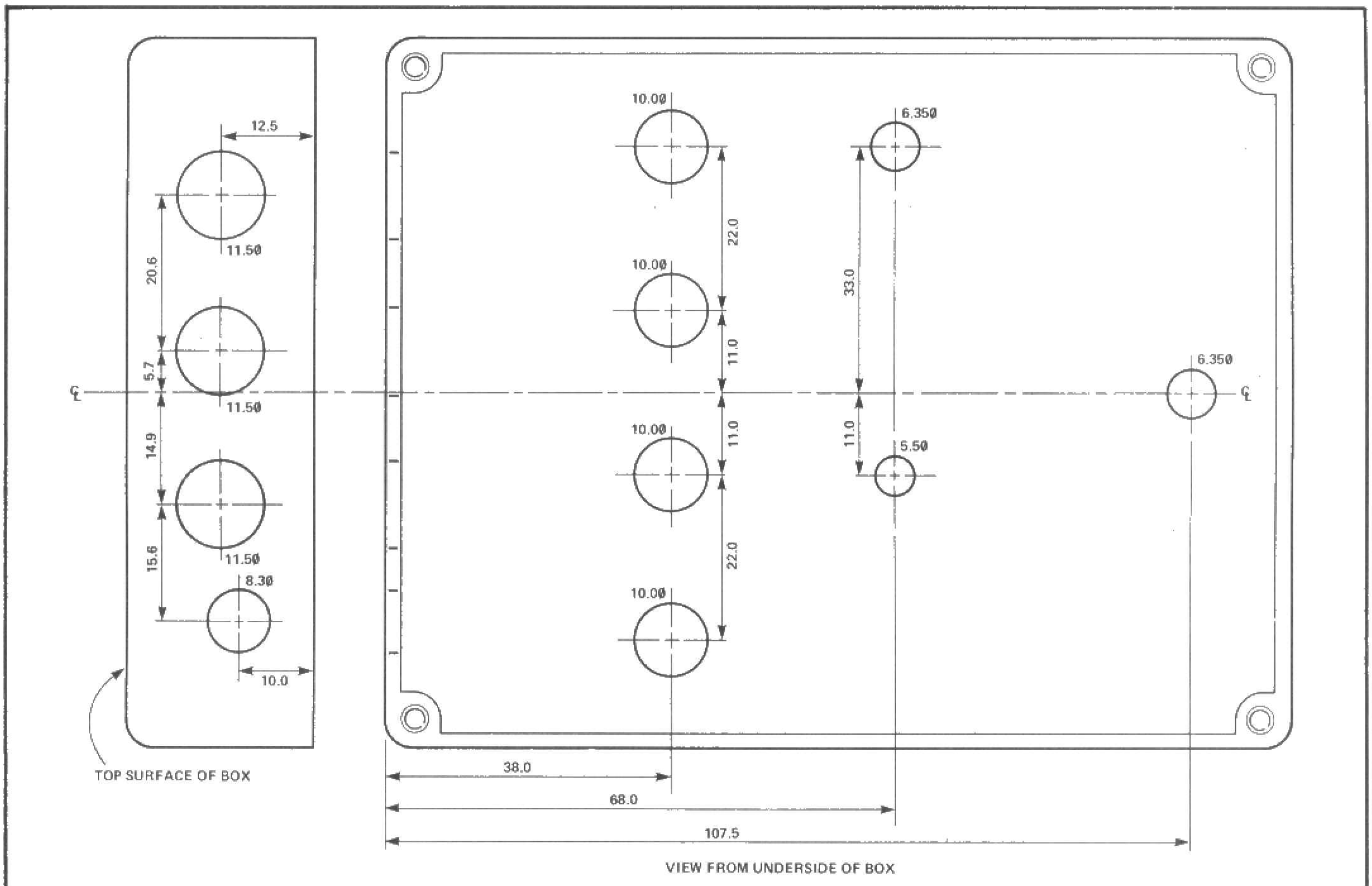


Fig. 4 Drilling details for the case, shown here actual size.

jack sockets and, if desired, sockets for ICs 3 and 5. The jack sockets must be of the recommended type if they are to fit correctly into the prepared holes on the PCB.

Continue assembly by soldering into place the resistors and capacitors, making sure that all the capacitors near the connector end of the board are mounted flat so as to make room for the potentiometers when the board is installed in its case. Next fit the diodes, transistors and ICs 1, 2 and 4 which must be soldered directly to the board or they, too, will not clear the potentiometers. ICs 3 and 5 are well clear of the potentiometer positions and will not cause problems if fitted using sockets. Cut to length four pieces of ordinary insulated connecting wire and solder them between the points shown on the PCB overlay, then fit the two battery guide pillars and the PCB is complete.

The next job is to prepare the box. It is best to use the recommended box if you want a particularly compact unit, but if you cannot obtain it then use a slightly larger box so as to avoid problems with the potentiometer mounting. Drill all the holes as accurately as you can, clean the box thoroughly with steel wool soap pads to remove any traces of grease or dirt, then paint it. When the paint is dry, the legends can be applied using rub-down lettering and a coat of clear varnish sprayed on to protect them. A piece of thin foam rubber should be glued to the inside of the box to prevent the battery from rattling around.

It is important to use the recommended potentiometers, switch and EXT. KEY socket or difficulty may be encountered in getting everything to fit within the space available. Mount the LED, the socket and the potentiometers through their respective holes in the front panel and connect them up to the PCB, taking care not to use greater lengths of wiring than is necessary. Solder the battery connector leads to the board and place one fibre washer on each of the three larger jack sockets. Mount the switch through its hole in the front panel but do not tighten it up.

Offer the PCB up to the case, guiding the jack sockets into their holes and aligning the switch pins with the pads provided. A little bit of force may be necessary, but any serious opposition should be investigated lest anything be damaged. When the PCB has settled into place, solder the switch pins onto their pads, tighten the switch mounting from the front panel and secure the large jack sockets with the nuts provided. Construction is then complete.

Setting Up And Use

Connect up a 9V battery, switch on, and apply a signal of about 2V peak-to-peak to the input. The LED should light up. Monitor the output with an oscilloscope or an AC millivoltmeter and adjust PR1 until the output level is of the same amplitude as the input level. This is the only adjustment necessary and if all is well the base can be screwed into place and the unit is ready for use.

In use, the noise-gate should come between any effects and the amplifier or tape-recorder. Connection should be by a screened cable as short as is practical. The unit is switched on by connecting a (mono) jack to the input socket.

When setting the noise-gate up initially, turn the sensitivity control

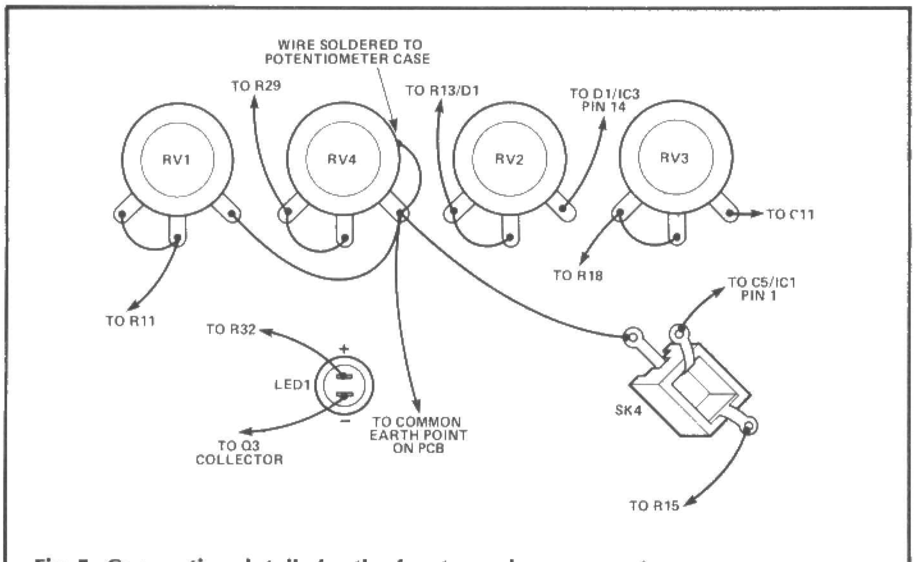


Fig. 5 Connecting details for the front panel components.

fully clockwise and the attack, hold and decay fully anticlockwise. The LED should be off: if it isn't, press the footswitch. If using any effects, switch them on to produce all the noises you're trying to get rid of, and rotate the threshold control anticlockwise (thus lowering the threshold) until the LED lights (at this stage you should be able to hear the noise getting through to your amplifier). Turn the threshold control slightly clockwise, raising the threshold just above the noise-floor. The LED should go off, and the noise should stop.

As you play your instrument, the gate should open, and should close when you stop. Remember that the other controls are still at a minimum, and should now be set to suit. Normally the attack will be left at a minimum, giving a short rise-time, with the hold and decay at about a second or so.

Pressing the footswitch will open the noise-gate regardless of input level, and is very useful when tuning-up. A remote footswitch can be connected to the REM socket, disconnecting the unit's own switch.

The noise-gate can also be used as an envelope shaper with the attack-hold-decay cycle being triggered in a number of ways. An audio signal can be connected via the EXT. KEY socket and will trigger the envelope shaper but still allow the threshold control to be used. Alternatively, the EXT. KEY should be shorted with a miniature jack plug and the unit triggered from the REM socket either by making and breaking a mechanical contact or by applying a logic signal. Closing the REM contacts or applying a 0V level will close the gate while opening the contacts or applying a +5 to +15V signal will open it.

ETI

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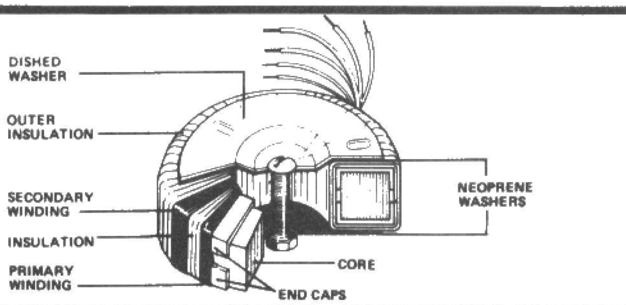

15 VA
62 x 34mm 0.35Kg
Regulation 19%

SERIES No	SECONDARY Volts	RMS Current
0x010	6+6	1 25
0x011	9+9	0 83
0x012	12+12	0 63
0x013	15+15	0 50
0x014	18+18	0 42
0x015	22+22	0 34
0x016	25+25	0 30
0x017	30+30	0 25

(encased in ABS plastic)

30 VA
70 x 30mm 0.45Kg
Regulation 18%

1x010	6+6	2 50
1x011	9+9	1 66
1x012	12+12	1 25
1x013	15+15	1 00
1x014	18+18	0 83
1x015	22+22	0 68
1x016	25+25	0 60
1x017	30+30	0 50

50 VA
80 x 35mm 0.9Kg
Regulation 13%

2x010	6+6	4 16
2x011	9+9	2 77
2x012	12+12	2 08
2x013	15+15	1 66
2x014	18+18	1 38
2x015	22+22	1 13
2x016	25+25	1 00
2x017	30+30	0 83
2x028	110	0 45
2x029	220	0 22
2x030	240	0 20

80 VA
90 x 30mm 1Kg
Regulation 12%

3x010	6+6	6 64
3x011	9+9	4 44
3-012	12+12	3 33
3x013	15+15	2 66
3x014	18+18	2 22
3x015	22+22	1 81
3x016	25+25	1 60
3x017	30+30	1 33
3x028	110	0 72
3x029	220	0 36
3x030	240	0 33

120 VA
90 x 40mm 1.2Kg
Regulation 11%

4x010	6+6	10 00
4x011	9+9	6 66
4x012	12+12	5 00
4x013	15+15	4 00
4x014	18+18	3 33
4x015	22+22	2 72
4x016	25+25	2 40
4x017	30+30	2 00
4x018	35+35	1 71
4x028	110	1 09
4x029	220	0 54
4x030	240	0 50

160 VA
110 x 40mm 1.8Kg
Regulation 8%

5x011	9+9	8 89
5x012	12+12	6 66
5x013	15+15	5 33
5x014	18+18	4 44
5x015	22+22	3 63
5x016	25+25	3 20
5x017	30+30	2 66
5x018	35+35	2 28
5x026	40+40	2 00
5x028	110	1 45
5x029	220	0 72
5x030	240	0 66

225 VA
110 x 45mm 2.2Kg
Regulation 7%

6x012	12+12	9 38
6x013	15+15	7 50
6x014	18+18	6 25
6x015	22+22	5 11
6x016	25+25	4 50
6x017	30+30	3 75
6x018	35+35	3 21
6x026	40+40	2 81
6x025	45+45	2 50
6x033	50+50	2 25
6x028	110	2 04
6x029	220	1 02
6x030	240	0 93

300 VA
110 x 50mm 2.6Kg
Regulation 6%

7x013	15+15	10 00
7x014	18+18	8 33
7x015	22+22	6 82
7x016	25+25	6 00
7x017	30+30	5 00
7x018	35+35	4 28
7x026	40+40	3 75
7x025	45+45	3 33
7x033	50+50	3 00
7x028	110	2 72
7x029	220	1 36
7x030	240	1 25

500 VA
140 x 60mm 4Kg
Regulation 4%

8x016	25+25	10 00
8x017	30+30	8 33
8x018	35+35	7 14
8x026	40+40	6 25
8x025	45+45	5 55
8x033	50+50	5 00
8x042	55+55	4 54
8x028	110	4 54
8x029	220	2 27
8x030	240	2 08

625 VA
140 x 75mm 5Kg
Regulation 4%

9x017	30+30	10 41
9x018	35+35	8 92
9x026	40+40	7 81
9x025	45+45	6 94
9x033	50+50	6 25
9x042	55+55	5 68
9x028	110	5 68
9x029	220	2 84
9x030	240	2 60

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30	1	7.67	225	6	13.75
50	2	8.90	300	7	14.97
80	3	10.06	500	8	19.60
120	4	10.65	625	9	22.30

For 110V primary insert "O" in place of "X" in type number.
For 220V primary (Europe) insert "1" in place of "X" in type number.
For 240V primary (UK) insert "2" in place of "X" in type number.
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ELECTRON SECOND PROCESSOR

It doesn't take ESP to know that we're dealing with the software for John Wike's Electron add-on.

Having described the hardware for this project last month, it is now time to consider the software. When RUN the program creates a 2K machine code file on tape or disc called E2PCODE. This latter is what must be *RUN to operate the second processor. Alternatively, if you have a disc it can be renamed as !BOOT and run using shift-break.

The listing given in this article has been produced using a formatting program to line it up nicely. If you intend to enter it yourself you must leave out all the spaces (except those after the '.' labels) or it will not fit into memory.

The beauty of the Acorn machines is that in order to intercept the input/output operations of any language it is only necessary to modify eleven well-documented operating systems (OS) routines. Detailed descriptions of these can be found in 'The Acorn Electron Advanced User Guide' by Holmes and Dickens, and 'The Advanced User Guide for the BBC Micro' by Bray, Dickens, Holmes. The operating system calls are the same for both machines and while one book also covers the special hardware in the Electron, the other is more readily available in the shops.

Memory Usage

In this article the Electron processor will be referred to as the I/O processor because that is its main function in the new environment. The second processor will be called 2P for short.

The E2PCODE program loads into addresses 2800 h to 2FFF h in the I/O memory, as shown in the memory map. This is below the highest resolution screen. It uses memory (again I/O) at 0 to 70 h and 400 h to 40B h so it is *important* that no user programs corrupt these three areas of I/O memory.

The main program is in three sections. Lines 190 to 4880 run where they are in I/O memory. Lines 5930 to 7250 are copies to the 256 byte sideways ROM area and exist at 8000 h in I/O memory and FFOO h in 2P memory. Finally, lines 7300 to 11100 are passed to 2P memory at F800 h to FAFF h.

Communication

The processors communicate with each other by way of various locations in 2P RAM which are used as status and data registers. Their functions are listed in Table 1 and, together with the 28byte Oswrch buffer, they overwrite the 2P reset routine in lines 6020 to 6230. As there is no hard reset that routine is not needed again anyway. With all the registers, except the buffer pointers, a zero value indicates that the message data has been received and acted on.

Facilities

This implementation has the ability to reset into the I/O processor by pressing B-break, ie. hold down the B key while pressing BREAK. Programs can then be developed in the I/O memory without switching off. In I/O HIMEM is set to 2800 h to protect the program. In 2P HIMEM is 8000 h and PAGE is 800 h.

If you execute *HELP while in 2P you will get the message "E2P 0.1". This does not appear if you are in the I/O.

Just one word of warning. Do not use any EVENT handlers in 2P that call OS routines. If you do the system will most probably hang up.

You will have to find out by trial and error which programs will work with a second processor. Anything that accesses screen memory or hardware directly will not work, since this can only be done by OS commands across the interface.

Address I/O(2P)	Function	Possible Values
800D(FFOD) h	Pass Instruction to 2P	8 h Start memory read(0) 9 h Start memory write(1) C h Run program(4) 28 h Stop memory read/write 40 h Handle Event code 80 h Pass BRK error message C0 h Set/Reset Escape flag FF h Initialise 2P (Reset)
8013(FF13) h	Pass OS call to I/O	Address of I/O OS routine
8019(FF19) h	Status for I/O to 2P data at 801A(FF1A) h	40 h Data is text 80 h Data is not text C0 h End of data
801B(FF1B) h	Status for 2P to I/O data at 801C(FF1C) h	As for 8019(FF19) h
801E(FF1E) h	Oswrch buffer insert pointer	Pointers equal if buffer empty
801D(FF1D) h	Oswrch buffer remove pointer	"
8014(FF14) h	Flush Oswrch buffer flag	Equal to 801E(FF1E) h

Table 1. Communication protocols.

I/O OPERATION

When the program is run the I/O processor enters the cold start routine at line 1250. At lines 1350 to 1630 it checks each ROM number from 7 down to 0 for a block of RAM of 256 bytes or less. If it finds one it assumes that it is the E2P card and stores the ROM number in location 'this ROM', if not it returns to the language ROM and prints the error query, ??.

If the ROM is not logged in already (1640-1670), it then cycles through the RAM (1690-1720), loads the RAM (1740-1770) and clears the 2P reset (1780). The RAM is then cycled to refresh it (1800-1820) until the 2P signals that it is ready (1830-1840). It then initiates a 2P memory write and transfers the 2P operating system routines over (1860-2040) before soft resetting itself (2050).

During I/O reset the operating system calls the sideways ROM service routines at 8003 h (line 5940) with the Tube reset code FE h in the accumulator. This is detected at line 2350 and the Osbyte vector is changed (2480-2570) to allow the new routine (3000-3140) to set HIMEM and inhibit the memory clear facility. Lines 2590-2670 check for the B key(64 h in line 2630). If it is not pressed the Tube presence at Osbyte EA h and the I/O/second processor flag at isec are set. The 2P is initialised (2700-2740). The vectors are changed, the soft character set is exploded, the filing system status is set and the sign on message is printed (2670-2920) before leaving the service routine.

Before the I/O can communicate with the 2P it must select the correct sideways ROM location. This is done with the routine at 3230-3320.

If the Tube presence flag is set during I/O reset the operating system will not start up a language but will jump instead to location 400h. This has been loaded at line 2690 (via lines 380-430) with the code in lines 210-240. So it will enter the warm start routines at line 4120. Pointers are set up to transfer the current language to 2P memory either at 8000h (4130-4180) or at a specified relocation address (4190-4300). If the language has been selected by a * command (4320), of if this is a cold start (4330-4340), or if it is a hard reset (4350-4370), and it is not Plus One control ROM at 0Cn (4380-4410), then the language will be transferred to 2P memory (4430-4550). The language will then be started up in 2P by issuing a Run Program command (4590-4680).

The actual routines to give instructions to 2P start at line 3340. The operating system will enter thse via the relocated line 230 at 406h, but they are called directly within this program. Lines 3340-3500 allow different filing systems to claim the 2P interface by entering with their file number plus C0h in the accumulator and waiting for the carry flag to be set. They release the interface using 80h plus the file number. The read, write and run instructions (0, 1 and 4 respectively) enter with YX pointing to two consecutive locations which hold the action address for the 2P. This address is sent in lines 3550-3660 then the actual instruction number ORed with 8 so that it cannot be zero is sent (3690-3710). If the instruction is to run a program, the I/O processor will enter its main loop, otherwise it will return (3740-3820).

The main loop routine (5540-5880) maintains the rotating Oswrch buffer remove pointer at 801D(FF1D)h. If the buffer is not empty its contents are printed. If it is empty the status register at 8013(FF13) h is examined and an OS call is executed if desired.

2P OPERATION

When the 2P reset is cleared it jumps via its reset vector at FFFC h (7240) to line 6020. Here it loads a 128 byte RAM refresh routine twice into FB00h to FBFFh. This consists of 'compare accumulator immediate' instructions (C9h), which are two bytes long and take two cycles to execute. Thus it will access 128 bytes in 128 cycles, or 64 microseconds. The last few bytes of the routine contain lines 6170-6230 which modify the calling routine to scan the other 128 bytes next time round (6170-6190) and check the status register at 800D(FF0D) h to see if any instructions need to be executed.

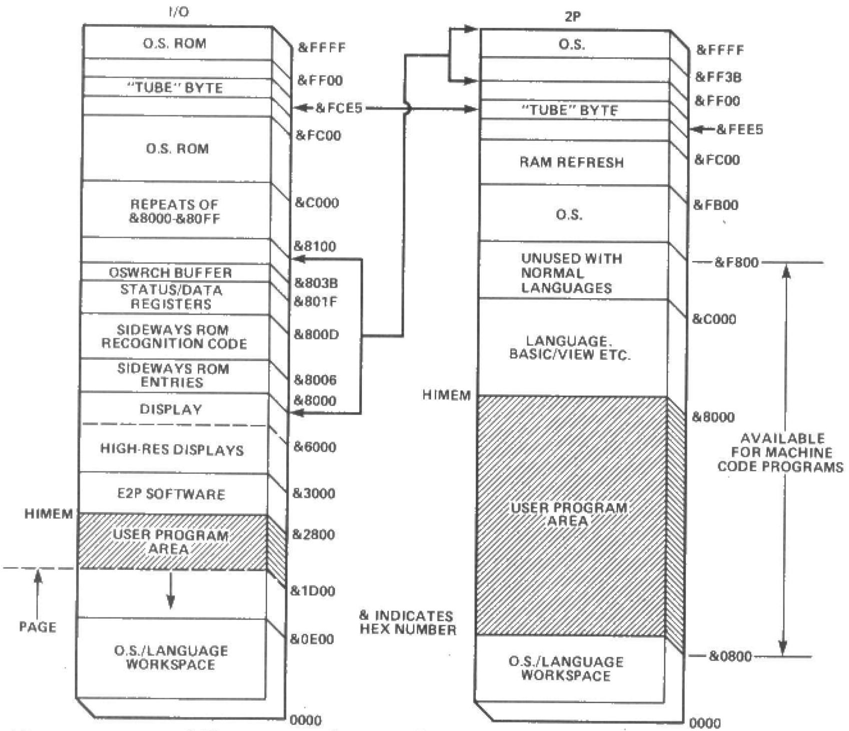
Normally the NMI routine (6400-6420) will call the cycle routine (6350-6380) to perform the refresh. However while the I/O is writing or reading 2P memory via the data register at FCE5(FEE5) h the 2P must respond quickly to the IRQ line. So the NMI is disabled and the 2P goes into the loop (6680-6700) where it is continually cycling to do the refresh. The read/write function is performed by modifying the three locations at ivec (6270) in the irql routine (6250-6330) to read or write the specified start address (6470-6550). If it is a read the first location is read by a software interrupt (6610-6620).

The other instructions are looked for in the test routines (7460-8310) and the appropriate action taken.

The 2P OS routines (8330-9720) interact with their I/O counterparts (450-1230) via the register at 8013(FF13)h. Some routines need to pass over the processor A,X and Y registers. Some need to pass text and some need block data. These are handled by the routines at lines 4700-5360, 6730-6780, and 9740-10320.

The Osword routines transfer different amounts of different size blocks. The tables at 10480-10910 are used to determine how much to send.

The 2P Osbyte routine checks for the memory functions 82h to 84 h (8420-8540). these give the machine high order address (FFFF h for I/O, 0000 h for 2P), PAGE, HIMEM, and HIMEM in other Modes, in that order. It also checks (8560-8640) whether the Oswrch buffer is being flushed (Osbyte DA h ,0,0) and sets the flag at 8014(FF14) h.



Memory maps of Electron and second processor board.

Listing of Electron program to run second processor.

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  50 REM    AS SPACE IS SHORT WHEN
  60 REM    USING DISCS, THE CODE IS
  70 REM    ASSEMBLED INTO SCREEN
  80 REM    MEMORY BEFORE SAVING.
  90 :
 100 MODE6
 110 VDU28,0,24,39,12
 120 VDU30
 130 :
 140 U%=&2800:V%=&6100
 150 A%=U%:B%=U%
 160 FOR I=4TO6STEP2
 170 O%=V%:P%=U%
 180 [ OPT I
 190              JMP cst
 200              :
 210 .cod400      JMP wst
 220              JMP esc
 230              JMP instr
 240 .osjmp       JMP osrdch
 250              :
 260 .pload       LDA (0),Y
 270              INC 0
 280              BNE pload2
 290              INC 1
 300              :
 310 .pload2      STA &FCE5
 320              :
 330              LDY #7
 340 .delay       DEY
 350              BNE delay
 360              RTS
 370              :
 380 .codld       LDX #&C
 390 .codld5      LDA cod400-1,X
 400              STA &3FF,X
 410              DEX
 420              BNE codld5
 430              RTS
 440              :
 450 .osrdch      JSR &FFCB
 460 .osrd1       JSR regso2
 470 .osret       LDA #0
 480              STA &8013
 490 .anrts       RTS
 500              :
 510 .oscli       JSR datin
 520              JSR &FFF7
 530              JMP osret
 540              :
 550 .osbyte      JSR regsin
 560              JSR &FFF4
 570              JSR regsout
 580              JMP osret
 590              :
 600 .osword      LDA &8016
 610              BNE oswd5
 620              JSR datin
 630              STX 0
 640              STY 1
 650              TXA
 660              TAY
 670              JSR &FFF1
 680              JSR regso3
 690              JSR osret
 700              BCS anrts
 710              JMP txtout
 720              :
 730 .oswd5       LDY #&20
 740              JSR datin1
 750              LDX #&20
 760              LDY #0
 770              LDA &8016
 780              JSR &FFF1
 790              JSR osret
 800              JSR regsin
 810              JMP blkout2
 820              :
 830 .osargs      JSR datin
 840              JSR regsi1
 850              JSR &FFDA
 860              JSR osrd1
 870              JMP blkout
 880              :
 890 .osbget      LDY &8018
 900              JSR &FFD7
 910              JMP osrd1
 920              :
 930 .osbput      JSR regsi1
 940              JSR &FFD4
 950              JMP osret
 960              :
 970 .osfind      JSR regsi1
 980              BEQ osf5
 990              PHA
1000              JSR datin
1010              PLA
1020 .osf5        JSR &FFCE
1030              JMP osrd1
1040              :
1050 .osfile      JSR datin
1060              JSR datin
1070              STX 0
1080              STY 1
1090              LDY #0
1100              LDA &8016
1110              JSR &FFDD
1120              JSR osrd1
1130              LDX #&12
1140              LDY #2
1150              JMP blkout2
1160              :
1170 .osgbpb      JSR datin
1180              LDY #0
1190              LDA &8016
1200              JSR &FFD1
1210              JSR osrd1
1220              LDX #&D
1230              JMP blkout1
1240              :
1250 .cst         SEI
1260              LDA #&40
1270              STA &D00
1280              LDA #&AA
1290              LDX #0
1300              LDY #&FF
1310              JSR &FFF4
1320              STX &F6
1330              STY &F7
1340              :
1350              LDX &F4
1360              LDY #7
1370 .cst1        TYA
1380              JSR sidesel
1390              LDA &8000
1400              CMP &B100
1410              BNE cst5
1420              EOR #&FF
1430              STA &8000
1440              CMP &8100
1450              PHP
1460              EOR #&FF
1470              STA &8000
1480              PLP
1490              BEQ cst7
1500              :
1510 .cst5        DEY
1520              BPL cst1
1530              TXA
1540              JSR sidesel
1550              BRK
1560              BRK
1570              EQUS "??"
1580              EQUB &D
1590              BRK
1600              :
1610 .cstvec      EQUW tclear
1620              :
1630 .cst7        STY thisROM
1640              LDA (&F6),Y
1650              BEQ cst10
1660              CMP &8006
1670              BEQ cst16
1680              :
1690 .cst10       LDX #0
1700 .cst11       LDA &8000,X
1710              INX
1720              BNE cst11
1730              :
1740 .cst12       LDA B%,X
1750              STA &8000,X
1760              INX
1770              BNE cst12
1780              LDA &FCE5
1790              :
1800 .cst15       LDA &8000,X
1810              INX
1820              BNE cst15
1830              LDA &800D
1840              BNE cst15
1850              :
1860 .cst16       LDX #cstvec MOD 256
1870              LDY #cstvec DIV 256
1880              LDA #1
1890              JSR instr
1900              :
1910              LDA #C% MOD 256
1920              STA 0
1930              LDA #C% DIV 256
1940              STA 1
1950              LDY #0
1960              STY langflg
1970              :
1980 .cst17       JSR pload
1990              LDA 0
2000              CMP #D% MOD 256
2010              BNE cst17
2020              LDA 1
2030              CMP #D% DIV 256
2040              BNE cst17
2050              JMP (&FFFC)
2060              :
2070 .message1 EQUB &D
2080              EQUS "E2P 0.1"
2090              EQUB &D
2100              EQUB 0
2110              :
2120 .message2 EQUS "SECOND PROCESSOR"
2130              EQUB &D
2140              EQUB &D
2150              EQUB 0
2160              :
2170 .prnmes      LDX #0
2180 .prnmes2     LDA message1,X
2190              BEQ prnmes5
2200              JSR &FFE3
2210              INX
2220              BNE prnmes2
2230 .prnmes5     RTS
2240              :
2250 .Rserv       CPX thisROM
2260              BNE Rserv3
2270              :
2280              CMP #9
2290              BNE Rserv2
2300              BIT isec
2310              BPL Rserv2
2320              JSR prnmes
2330              LDA #9
2340              :
2350 .Rserv2      CMP #&FE
2360 .Rserv3      BNE Rserv15
2370              :
2380              TYA
2390              PHA
2400              JSR &FFE7
2410              LDA #&A6
2420              LDX #0
2430              LDY #&FF
2440              JSR &FFF4
2450              STX &1D
2460              STY &1E
2470              :
2480              LDA &20B
2490              CMP #newosb DIV 256
2500              BEQ Rserv5
2510              STA oldosb+1
2520              LDA &20A
2530              STA oldosb
2540              LDA #newosb DIV 256
2550              STA &20B
2560              LDA #newosb MOD 256
2570              STA &20A
2580              :
2590  Rserv5      LDA #&7A
2600              JSR &FFF4
2610              LDY #0
2620              STY isec
2630              CPX #&64
2640              BNE Rserv7
2650              LDA #&78
2660              JSR &FFF4
2670              JMP Rserv10
2680              :
2690 .Rserv7      JSR codld
2700              LDA #&FF
2710              STA isec
2720              LDY #&EA
2730              STA (&1D),Y
2740              JSR pcomm
2750              :
2760              LDA #newbrk MOD 256
2770              STA &202
2780              LDA #newbrk DIV 256
2790              STA &203
2800              LDA #newevent MOD 256
2810              STA &220
2820              LDA #newevent DIV 256
2830              STA &221
2840              :
2850              LDA #&14
2860              LDX #6
2870              JSR &FFF4
2880              LDA #&80
2890              STA &14
2900              :
2910              LDX #message2-message1
2920              JSR prnmes2
2930              :
2940 .Rserv10     PLA
2950              TAY
2960              LDA #0
2970 .Rserv15     LDX &F4
2980              RTS
2990              :
3000 .newosb      CMP #&84
3010              BEQ newosb2
3020              CMP #&85
3030              BNE newosb5
3040 .newosb2     LDX #A% MOD 256
3050              LDY #A% DIV 256
3060              RTS
3070              :
3080 .newosb5     CMP #&C8
3090              BNE newosb7
3100              TXA
3110              AND #&FD
3120              TAX
3130              LDA #&C8
3140 .newosb7     JMP (oldosb)
3150              :
3160 .pcomm       STA &800D
3170 .pstat       NOP
3180              NOP
3190              LDA &800D
3200              BNE pstat
3210              RTS
3220              :
3230 .pselect     LDA thisROM
3240              JSR sidesel
3250              JMP pstat
3260              :
3270 .sidesel     STA &F4
3280              LDA #&C
3290              STA &FE05
3300              LDA &F4
3310              STA &FE05
3320              RTS
3330              :
3340 .instr       CMP #&80
3350              BCC instr4
3360              CMP #&C0
3370              BCC instr3
3380              ASL &14
3390              BCS instr1
3400              CMP &15
3410              BEQ instr2
3420              CLC
3430              RTS
3440 .instr1      STA &15
3450 .instr2      RTS
3460 .instr3      ORA #&40
3470              CMP &15
3480              BNE instr2
3490              LDA #&80
3500              STA &14
3510              LDA #&20
3520              :
3530 .instr4      PHP
3540              SEI
3550              STY &13
3560              STX &12
3570              STA &16
3580              LDA &F4
3590              PHA
3600              JSR pselect
3610              :
3620              LDY #1
3630 .instr5      LDA (&12),Y
3640              STA &8010,Y
3650              DEY
3660              BPL instr5
3670              :
3680              LDY &13
3690              LDA &16
3700              ORA #8
3710 .instr7      JSR pcomm
3720              PLA
3730              JSR sidesel
3740              LDA &16
3750              CMP #4
3760              BNE instr9
3770              :
3780 .instr8      LDA #&80
3790              STA &14
3800              JMP main
3810 .instr9      PLP
3820              RTS
3830              :
3840 .esc         PHP
3850              SEI
3860              LDA &F4
3870              PHA
3880              JSR pselect
3890              LDA &FF
3900              STA &8010
3910              LDA #&C0
3920              STA &16
3930              BNE instr7
3940              :
3950 .newevent STA &19
3960              PHP
3970              LDA &F4
3980              PHA
3990              JSR pselect
4000              STX &800E
4010              STY &800F
4020              LDA &19
4030              STA &8010
4040              LDA #&40
4050              JSR pcomm
4060              PLA
4070              JSR sidesel
4080              LDA &19
4090              PLP
4100              RTS
4110              :
4120 .wst         CLI
4130              LDY #0
4140              STY 0
4150              STY &17
4160              LDA #&80
4170              STA 1
4180              STA &18
4190              LDA #&20
4200              AND &8006
4210              BEQ wst2
4220              :
4230              LDX &8007
4240 .wst1        INX
4250              LDA &8000,X
4260              BNE wst1
4270              LDA &8001,X
4280              STA &17
4290              LDA &8002,X
4300              STA &18
4310              :
4320 .wst2        BCS wst4
4330              BIT langflg
4340              BPL wst4
4350              LDY #&FD
4360              LDA (&1D),Y
4370              BEQ wst99
4380 .wst4        LDA &F4
4390              CMP #&C
4400              BNE wst5
4410              JMP &8000
4420              :
4430 .wst5        LDA #1
4440              JSR wst100
4450 .wst7        JSR pload
4460              BIT 1
4470              BVS wst12
4480              :
4490 .wst10       LDA 0
4500              CLC
4510              ADC &17
4520              LDA 1
4530              ADC &18
4540              CMP #&FB
4550              BCC wst7
4560              :
4570 .wst12       LDA #&FF
4580              STA langflg
4590 .wst99       LDA #4
4600              :
4610 .wst100      PHA
4620 .wst110      LDA #&FF
4630              JSR instr
4640              BCC wst110
4650              PLA
4660              LDX #&17
4670              LDY #0
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```
4680            JMP instr
4690            :
4700 .regsout   STY &8018
4710 .regso1    STX &8017
4720 .regso2    STA &8016
4730 .regso3    ROL A
4740            STA &8015
4750            ROR A
4760            RTS
4770            :
4780 .regsin    LDX &8017
4790 .regsi1    LDY &8016
4800            LDA &8016
4810            RTS
4820            :
4830 .datin     LDY #0
4840 .datin1    LDX #0
4850 .datin2    BIT &8019
4860            BVC datin5
4870            BMI datin9
4880            LDA &801A
4890            STA &700,Y
4900            BVS datin7
4910            :
4920 .datin5    BPL datin2
4930            CPY #&1C
4940            BCC datin6
4950            CPY #&20
4960            BCC datin7
4970            CPY #&70
4980            BCS datin7
4990            :
5000 .datin6    LDA &801A
5010            STA 0,Y
5020 .datin7    CLV
5030 .datin9    STX &8019
5040            INY
5050            BVC datin2
5060            LDY #7
5070            RTS
5080            :
5090 .blkout    LDX #4
5100 .blkout1   LDY #0
5110 .blkout2   STX &1A
5120 .blkout3   LDX #&80
5130 .blkout5   CPY &1A
5140            BEQ txtout5
5150            LDA 0,Y
5160            JSR datout
5170            INY
5180            BNE blkout5
5190            :
5200 .txtout    LDX #&40
5210            LDY #0
5220 .txtout2   LDA &700,Y
5230            JSR datout
5240            INY
5250            CMP #&D
5260            BNE txtout2
5270 .txtout5   LDX #&C0
5280            :
5290 .datout    NOP
5300            NOP
5310            BIT &801B
5320            BVS datout
5330            BMI datout
5340            STA &801C
5350            STX &801B
5360            RTS
5370            :
5380 .newbrk    LDY #&FF
5390 .newbrk2   INY
5400            LDA (&FD),Y
5410            STA &20,Y
5420            TAX
5430            BNE newbrk2
5440            TYA
5450            BEQ newbrk2
5460            INY
5470            STY &1A
5480            LDY #&20
5490            JSR pselect
5500            LDA #&80
5510            JSR pcomm
5520            JSR blkout3
5530            :
5540 .main      LDX #&FF
5550            TXS
5560 .main2     SEI
5570            LDA thisROM
5580            JSR sidesel
5590            CLI
5600 .main3     LDX &8014
5610            BEQ main4
5620            STX &801D
5630            LDA #0
5640            STA &8014
5650            :
5660 .main4     LDX &801D
5670            CPX &801E
5680            BEQ main9
5690            :
5700            INX
5710            CPX #irq1 MOD 256
5720            BCC main7
5730            LDX #&1F
5740 .main7     LDA &8000,X
5750            STX &801D
5760            JSR &FFCB
5770            JMP main3
5780            :
5790 .main9     LDA &8013
5800            BEQ main2
5810            :
5820            LDX &801D
5830            CPX &801E
5840            BNE main3
5850            :
5860            STA osjmp-cod400+&401
5870            JSR osjmp-cod400+&400
5880            JMP main
5890            ]
5900 B%=O%-V%+U%
5910 P%=&FF00
5920 [ OPT I
5930            JMP wst
5940            JMP Rserv
5950            EQUB &82
5960            EQUB 8
5970            EQUB 0
5980            EQUS "(C)"
5990            EQUB 0
6000            EQUB &FF
6010            :
6020 .reset     LDX #&FF
6030            TXS
6040 .reset2    LDA codtabe-&FF,X
6050 .reset4    STA &FB00,X
6060            STA &FAB0,X
6070            DEX
6080            CMP #&C9
6090            BNE reset2
6100            DEX
6110            BMI reset4
6120            LDA #test7 MOD 256
6130            STA &FFFC
6140            BNE test7
6150            :
6160            CMP #0
6170            LDA cycle+1
6180            EOR #&80
6190            STA cycle+1
6200            LDA &FF0D
6210            CMP &90
6220            STA &90
6230 .codtabe   RTS
6240            :
6250 .irq1      PHA
6260            LDA &FEE5
6270 .ivec      STA &200
6280            STA &FEE5
6290            INC ivec+1
6300            BNE irq2
6310            INC ivec+2
6320 .irq2      PLA
6330 .anrti     RTI
6340            :
6350 .cycle     JSR &FB00
6360            BEQ cycle5
6370            ORA #0
6380 .cyche5    RTS
6390            :
6400 .nmi       PHA
6410            JSR cycle
6420            BEQ irq2
6430            :
6440 .test      CMP #9
6450            BCC test2
6460            BNE test10
6470            LDA #&8D
6480            BNE test4
6490            :
6500 .test2     LDA #&AD
6510 .test4     STA ivec
6520            LDA &FF10
6530            STA ivec+1
6540            LDA &FF11
6550            STA ivec+2
6560            :
6570            LDA #irq1 MOD 256
6580            STA &FFFE
6590            LDA #anrti MOD 256
6600            STA &FFFA
6610            BCS test6
6620            BRK
6630            NOP
6640            :
6650 .test6     CLI
6660 .test7     LDA #0
6670            STA &FF0D
6680 .test8     JSR cycle
6690            BNE test
6700            BEQ test8
6710 .test10    JMP test12
6720            :
6730 .regsin10  LDY &FF18
6740 .regsin11  LDX &FF17
6750 .regsin12  LDA &FF15
6760            ROR A
6770            LDA &FF16
6780            RTS
6790            :
6800 .irq5      STA &FC
6810            PLA
6820            ORA #4
6830            PHA
6840            AND #&10
6850            BEQ irq7
6860            :
6870            TXA
6880            PHA
6890            TSX
6900            LDA &103,X
6910            CLD
6920            SEC
6930            SBC #1
6940            STA &FD
6950            LDA &104,X
6960            SBC #0
6970            STA &FE
6980            PLA
6990            TAX
7000            LDA &FC
7010            JMP (&202)
7020 .irq7      LDA &FC
7030            RTI
7040            :
7050 .evjmp     JMP (&220)
7060            :
7070            JMP (&21C)
7080            JMP (&21A)
7090            JMP (&218)
7100            JMP (&216)
7110            JMP (&214)
7120            JMP (&212)
7130            JMP (&210)
7140            CMP #&D
7150            BNE &FFEE
7160            LDA #&A
7170            JSR &FFEE
7180            LDA #&D
7190            JMP (&20E)
7200            JMP (&20C)
7210            JMP (&20A)
7220            JMP (&208)
7230            EQUW anrti
7240            EQUW reset
7250            EQUW anrti
7260            ]
7270 C%=O%-V%+U%
7280 P%=&FB00
7290 [ OPT I
7300 .tclear    LDA &FF1E
7310            STA &FF14
7320            LDA #0
7330            STA &FF13
7340            STA &FF19
7350            STA &FF1B
7360            :
7370 .tclear10  LDA #irq5 MOD 256
7380            STA &FFFE
7390            LDA #nmi MOD 256
7400            STA &FFFA
7410            :
7420 .tclear20  LDA #0
7430            STA &FF0D
7440            RTS
7450            :
7460 .test12    CMP #&C
7470            BNE test15
7480            LDX #&FF
7490            TXS
7500            LDA &FF11
7510            PHA
7520            LDA &FF10
7530            PHA
7540            SEI
7550            PHP
7560            JSR tclear
7570            LDA #1
7580            RTI
7590            :
7600 .test15    CMP #&28
7610            BEQ test92
7620            BCC test92
7630            :
7640            CMP #&FF
7650            BNE test20
7660            TAX
7670            TXS
7680            INX
7690            STX &FF
7700            LDX #&23
7710            STX &FF1E
7720 .test17    LDA vectab,X
7730            STA &200,X
7740            DEX
7750            BPL test17
7760            :
7770 .test1BA   JSR tclear
7780 .test1B    JMP test1B
7790            :
7800 .test20    CMP #&C0
7810            BNE test25
7820            LDA &FF10
7830            STA &FF
7840            BMI test92
7850            :
7860 .test90    LDA &FFFA
7870            CMP #anrti MOD 256
7880            BNE test95
7890            JMP test7
7900            :
7910 .test92    JSR tclear10
7920            PLA
7930            RTI
7940            :
7950 .test95    JSR tclear20
7960            PLA
7970            RTI
7980            :
7990 .test25    CMP #&40
8000            BNE test30
8010            TXA
8020            PHA
8030            TYA
8040            PHA
8050            LDX &FF0E
8060            LDY &FF0F
8070            LDA &FF10
8080            JSR evjmp
8090            PLA
8100            TAY
8110            PLA
8120            TAX
8130            JMP test90
8140            :
8150 .test30    TXA
8160            PHA
8170            TYA
8180            PHA
8190            JSR tclear
8200            LDX #0
8210            STX &FD
8220            LDY #&FD
8230            STY &FE
8240            JSR datin10
8250            PLA
8260            TAY
8270            PLA
8280            TAX
8290            PLA
8300            STA &FC
8310            JMP (&202)
8320            :
8330 .osrdch10  LDA #osrdch MOD 256
8340            JSR oscomm
8350            JMP regsin12
8360            :
8370 .oscli10   LDA #oscli MOD 256
8380            STA &FF13
8390            JSR txtout10
8400            JMP osstat
8410            :
8420 .osbyte10  CMP #&82
8430            BCC osbyte15
8440            CMP #&86
8450            BCS osbyte15
8460            TAX
8470            LDY osbtab-&82,X
8480            LDX #0
8490 .anrts10   RTS
8500            :
8510 .osbtab    EQUB 0
8520            EQUB 8
8530            EQUB &80
8540            EQUB &80
8550            :
8560 .osbyte15  CMP #&DA
8570            BNE osbyte20
8580            TXA
8590            BNE osbyte18
8600            TYA
8610            BNE osbyte18
8620            LDA &FF1E
8630            STA &FF14
8640 .osbyte18  LDA #&DA
8650 .osbyte20  JSR regso10
8660            LDA #osbyte MOD 256
8670            JSR oscomm
8680            JMP regsin10
8690            :
8700 .osword10  STA &FF16
8710            LDA #osword MOD 256
8720            STA &FF13
8730            LDA &FF16
8740            BNE oswd15
8750            LDA #5
8760            JSR blkout10
8770            JSR osstat
8780            JSR regsin12
8790            BCS anrts10
8800            LDY #0
8810            LDA (&93),Y
8820            TAX
8830            INY
8840            LDA (&93),Y
8850            TAY
8860            JMP datin10
8870            :
8880 .oswd15    STX &F0
8890            CMP #&E
8900            BCC oswd17
8910            LDA #&E
8920            :
8930 .oswd17    TAX
8940            LDA oswifrm-1,X
8950            STA &FF18
8960            LDA oswito-1,X
8970            STA &FF17
8980            LDA oswoto-1,X
8990            LDX &F0
9000            JSR blkout10
9010            JSR osstat
9020            LDA &FF18
9030            AND #&1F
9040            JSR datin11
9050            JMP blkout19
9060            :
9070 .osargs10  JSR regso10
9080            LDA #osargs MOD 256
9090            STA &FF13
9100            LDY #0
9110            LDA #4
9120            CLD
9130            JSR blkout10
9140            JSR osstat
9150            JSR datin10
9160            JMP regsin10
9170            :
9180 .osbget10  STY &FF18
9190            LDA #osbget MOD 256
9200 .osbget12  JSR oscomm
9210            JMP regsin12
9220            :
9230 .osbput10  JSR regso11
9240            LDA #osbput MOD 256
9250            BNE osbget12
9260            :
9270 .osfind10  JSR regso10
9280            PHA
9290            LDA #osfind MOD 256
9300            STA &FF13
9310            PLA
```

```
9320             BEQ osfind20
9330             JSR txtout10
9340             :
9350 .osfind20   JSR osstat
9360             JMP regsin10
9370             :
9380 .osfile10   STA &FF16
9390             LDA #osfile MOD 256
9400             STA &FF13
9410             LDA #&12
9420             JSR blkout10
9430             LDY #0
9440             LDA (&93),Y
9450             TAX
9460             INY
9470             LDA (&93),Y
9480             TAY
9490             JSR txtout10
9500             JSR osstat
9510             LDX &93
9520             LDY &94
9530             LDA #2
9540 .osfile15   JSR datin11
9550             LDX &93
9560             LDY &94
9570             JMP regsin12
9580             :
9590 .osgbpb10   STA &FF16
9600             LDA #osgbpb MOD 256
9610             STA &FF13
9620             LDA #&D
9630             JSR blkout10
9640             JSR osstat
9650             CLD
9660             LDA #0
9670             BEQ osfile15
9680             :
9690 .oscomm     STA &FF13
9700 .osstat     LDA &FF13
9710             BNE osstat
9720             RTS
9730             :
9740 .regso10    STX &FF17
9750 .regso11    STY &FF18
9760             STA &FF16
9770             RTS
9780             :
9790 .txtout10   STX &91
9800             STY &92
9810             LDX #&40
9820             LDY #0
9830 .txtout12   LDA (&91),Y
9840             JSR datout10
9850             INY
9860             CMP #&D
9870             BNE txtout12
9880 .txtout15   LDX #&C0
9890             :
9900 .datout10   BIT &FF19
9910             BVS datout10
9920             BMI datout10
9930             STA &FF1A
9940             STX &FF19
9950 .datout15   RTS
9960             :
9970 .blkout10   STA &95
9980 .blkout11   STX &93
9990             STY &94
10000            LDX #&80
10010            LDY #0
10020 .blkout15  CPY &95
10030            BEQ blkout17
10040            LDA (&93),Y
10050            JSR datout10
10060            INY
10070            BNE blkout15
10080            :
10090 .blkout17  JSR txtout15
10100 .blkout19  LDX &93
10110            LDY &94
10120            RTS
10130            :
10140 .datin10   LDA #0
10150 .datin11   STX &96
10160            STY &97
10170            TAY
10180            LDX #0
10190 .datin12   BIT &FF1B
10200            BVC datin15
10210            BMI datin19
10220            BPL datin17
10230            :
10240 .datin15   BPL datin12
10250 .datin17   LDA &FF1C
10260            STA (&96),Y
10270            CLV
10280            :
10290 .datin19   STX &FF1B
10300            INY
10310            BVC datin12
10320            RTS
10330            :
10340 .oswrch10  STX &9F
10350            LDX &FF1E
10360            INX
10370            CPX #irq1 MOD 256
10380            BCC oswrch15
10390            LDX #&1F
10400 .oswrch15  CPX &FF1D
10410            BEQ oswrch15
10420            :
10430            STA &FF00,X
10440            STX &FF1E
10450            LDX &9F
10460            RTS
10470            :
10480 .oswoto    EQUB 0
10490            EQUB 5
10500            EQUB 0
10510            EQUB 5
10520            EQUB 4
10530            EQUB 5
10540            EQUB 8
10550            EQUB &E
10560            EQUB 4
10570            EQUB 1
10580            EQUB 1
10590            EQUB 5
10600            EQUB 0
10610            EQUB &10
10620            :
10630 .oswifrm   EQUB &20
10640            EQUB &20
10650            EQUB &20
10660            EQUB &20
10670            EQUB &24
10680            EQUB &20
10690            EQUB &20
10700            EQUB &20
10710            EQUB &24
10720            EQUB &21
10730            EQUB &21
10740            EQUB &20
10750            EQUB &20
10760            EQUB &20
10770            :
10780 .oswito    EQUB &25
10790            EQUB &20
10800            EQUB &25
10810            EQUB &20
10820            EQUB &25
10830            EQUB &20
10840            EQUB &20
10850            EQUB &20
10860            EQUB &25
10870            EQUB &29
10880            EQUB &25
10890            EQUB &20
10900            EQUB &28
10910            EQUB &30
10920            :
10930 .vectab    EQUW anrts10
10940            EQUW test18A
10950            EQUW irq7
10960            EQUW irq7
10970            EQUW oscli10
10980            EQUW osbyte10
10990            EQUW osword10
11000            EQUW oswrch10
11010            EQUW osrdch10
11020            EQUW osfile10
11030            EQUW osargs10
11040            EQUW osbget10
11050            EQUW osbput10
11060            EQUW osgbpb10
11070            EQUW osfind10
11080            EQUW anrts10
11090            EQUW anrts10
11100            EQUW anrts10
11110            :
11120            ]
11130 D%=O%-V%+U%
11140 P%=D%
11150 [ OPT I
11160 .langflg  EQUB 0
11170 .isec     EQUB 0
11180 .oldosb   EQUW 0
11190 .thisROM  EQUB 0
11200           ]
11210 NEXT
11220 PRINT"IF YOU ARE USING TAPES,"
11230 PRINT"INSERT CASSETTE THAT WILL
HOLD RUN CODE,"
11240 OSCLI"SAVE E2PCODE FFFF"+STR$~V
%+" +"+STR$~(D%-A%)+" FFFF"+STR$~U%+"
FFFF'+STR$~U%
11250 VDU26
11260 CLS
>
```

The PCB described last month and the software are available from the author at 9, Lon-y-Garwa, Caerphilly, Mid-Glamorgan. The price of the PCB is £12, software on tape is £3.50, and on your disc £2.00, inclusive of postage. If you send a disc please state whether you wish to have the !BOOT file put on

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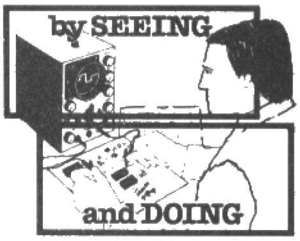

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UNIVERSAL EPROM PROGRAMMER MKII

In which Gordon Bennett jumps to all the right subroutines so that you can blow your EPROMs and blow your minds with the software for Mike Bedford's better programmer.

When the original articles for the Universal Eprom programmer were published, I was in the process of looking for a new Eprom blower, as the one I was using was horrendously slow. It was a much modified serial driven device originally published in the December 1978 'Computing Today', when this was still a supplement given away in ETI.

However, it was several months before I embarked on the construction of the Universal Eprom Programmer board. It then became apparent that the control software was somewhat unwieldy in its form of both a machine code and BASIC program and that something easier to load and use was required. This prompted me to write a suitable control Eprom for use in the spare slot at E800h in the Microtan memory map.

This Eprom eventually found its way into the hands of Mike Bedford and led to a phone call in which he asked if I would be interested in writing the software for a new enhanced version of the programmer that was under development. The new programmer was to be capable of supporting the interactive programming algorithms which allow the larger devices to be programmed in much reduced times, a 27128 in about 2 minutes and a 27512 in 7 minutes.

The resulting program is described in this article. An idea of the Eproms supported can be gained from Table 1, which also gives a list of those that have actually been programmed using the new hardware and software.

One reason for creating the software package in an Eprom is that it saves considerable time not having to load both a BASIC and machine code program from tape. Those with discs will not find this so much of a problem, of course. Another reason for using an Eprom based package is the efficient memory utilisation. There never seems to be enough memory available even when you have a lot. People with small memories (Sorry! people with small computer memories) are in an even worse position. It is annoying to have a large chunk of your computer memory taken up by the

EPROM TYPE	SOFTWARE SUPPORTED	ALGORITHM FAST/SLOW	WHETHER PROGRAMED
2758	YES	S	NO
2716	YES	S	YES
2516	YES	S	NO
2732	YES	S	YES
2732A	YES	S	NO
2532	YES	S	YES
68732	NO		
2764	YES	F/S	YES
2764A	YES	F/S	NO
2564	YES	F/S	NO
68764	NO		
27128	YES	F/S	YES
27128A	YES	F/S	NO
27256	YES	F/S	YES
27512	YES	F/S	NO
27513*	NO		
2816**	NO		
2864	NO		

* The 27513 is selectable in four 16K banks, each of which is programmed as if it were a 16K Eprom in its own right. Although the programmer software will handle 16K Eproms there is no ability built into it to allow to allow the bank selection mechanism to operate.

** The 2816 Eprom requires only a short pulse to initiate the internal programming cycle followed by a delay of 10ms to allow completion. The software does not support this as it stands but would need minimal changes to allow the use of this device.

Table 1 EPROMs supported by the programmer.

control programs. It often means making two passes when programming.

Ease of use is of prime importance in a package of this type and to this end it has been made as simple as possible to move back and forth between Eprom programmer software and Tanbug monitor. The programmer software has both a cold and warm start vector, the cold start is at E800h and the warm start is at E803h.

The software should always be entered the first time at E800h as this performs the initialisation of the PIOs. If it becomes necessary to leave the programmer, when developing software with an assembler or using the Tanbug monitor facilities, then re-entry is via E803h.

The provision of memory modify and list commands was not necessary. The ease of movement in and out of the program makes it simple to use the Tanbug and X-bug monitor commands for modification, listing and disassembly. There is one command, however, that is useful for displaying the contents of memory, both on the screen and on a printer: the Dump command. It was developed as an aid to give hexadecimal printer dumps of areas of memory, during Eprom development.

The software actually implements three different Fast programming algorithms depending on the type of Eprom being programmed. For the 2764 and 27128 the flowchart is similar to the one featured in the original article (ETI, August 1983). The 27256 and 27512 are slightly different and this is reflected in the flowcharts of the algorithms for these two Eproms (Figs. 1 and 2). The method used by the 27512 should be quicker than that for the 27256, and approximate times for those Eproms programmed so far are shown in Table 2.

EPROM		PROGRAM			
TYPE	SIZE	SLOW	FAST	TEST	VERIFY
MEASURED TIMES					
2716	2K	1.75m	—	1.25s	1.25s
2732	4K	3.5m	—	2.5s	2.5s
2532	4K	3.5m	—	2.5s	2.5s
2764	8K	7.5m	1m	5s	5s
27128	16K	15.5m	2m	10s	10s
27256	32K	30m	4m	20s	20s
ESTIMATED TIMES					
2758	1K	0.8m	—	0.6s	0.6s
27512	64K	60m	7m	41s	41s

Table 2 Approximate programming speeds.

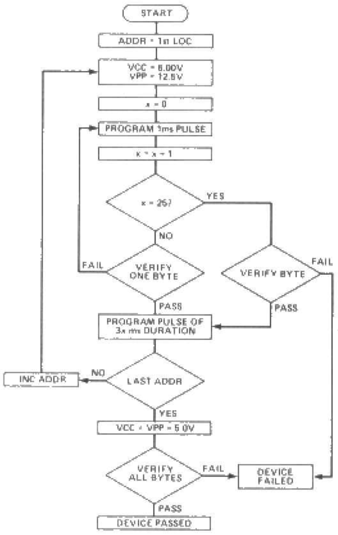


Fig. 1 Flowchart for 27256 programming routine.

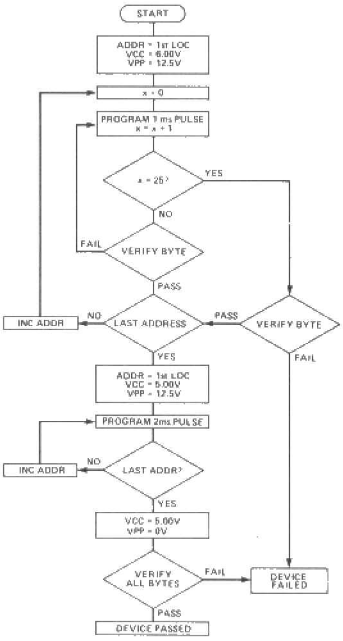


Fig. 2 Flowchart for 27512 programming routine.

Points Of Note

The present package (EP3V75) will support the new hardware for both fast and slow methods of programming. It will *not* support the original hardware as I/O bits are assigned to the PIO ports in a different way. Whilst the package will work with Tanbug V2.3 and V3.1 it will not work with V1.0, because of the way in which the system routine calls are vectored through the jump table at the beginning of Tanbug.

In a 2K package such as this it is not possible to include all desirable features — particularly totally comprehensive error checking. Providing a sensible approach, the error checking should be adequate. Entering only the command letter when parameters are required will cause the command action to operate on the first byte at the present Base. Entering parameters in the wrong order will be trapped and a '?' displayed.

Testing a 27512 Eprom must be done in two 32K parts, and will produce two 'EPROM ERASED OK' messages, approximately 20 seconds apart. This is not an error — honest!

Hardware Configuration

The program assumes that the Eprom Programmer board is based at address BC20h. The original Microtan screen is assumed for obtaining parameters, and in the clear screen routine. Locations in zero page from 45h to 5Fh, are used. The Eprom programming software re-initialises the locations it needs when entry is made at E800h. If other user programs are in memory at the same time occupying any of these locations the contents will be overwritten.

Menu And Commands

The program us started from the Tanbug monitor by typing GE800<CR>. You are then asked to enter the type of Eprom that you wish to program and the base address at which your object code resides in memory. You should then see a display of current Eprom type, current base address and the menu of available commands.

This screen display is shown below. It can be obtained at any time, when not actually executing a command, by pressing the 'H' key.

```
EPROM=XXXXX  BASE=$HHHH
(H)elp
(Q)uit
(T)est
(R)ead
(V)erify
(F)ast prog.
(S)low prog.
(D)ump
(N)ew type
(B)ase
```

The command input format uses the capital initial letter of the command, as shown on the help menu. Some commands — 'Help', 'Quit' and 'Test' — execute immediately. Others, like 'New type' and 'Base', prompt for a further input. The rest require a parameter range. The normal format is:

X,ssss,ffff
(X is the start address in hex and ffff is the finish address in hex).
The delineator can be any non alphanumeric.

Unlike the old version of the software the range parameters do not require leading zeros. All of the following are valid commands:

R,0,7FF or R,0000,7FF reads 0 to 7FF.
S,801,802 slow programs 801 and 802.
F,FFF,FFF fast programs location FFF.
D/0/2FF and D—100,1FF both dump to the screen.

All commands that act on the Eprom socket also turn off the green LED and, in case of a programming command, turn on the red LED.

If the range of the parameters entered is too big for the Eprom type selected, the message 'EPROM SIZE EXCEEDED' will be displayed.

120 Command Description

An explanation of the commands may be useful since there are many new features.

HELP:- gives a display of the current Eprom type, base address and the commands available, exactly as it you had just entered the program from Tanbug.

QUIT:- takes you back into the Tanbug monitor and resets the stack, after making the PIO outputs safe.

TEST:- examines the Eprom to see if all locations contain FFh. If they do, you should get a message 'EPROM ERASED OK'. Otherwise you will get a display of the addresses and contents. If there are more than fourteen locations not containing FFh, the program waits for you to press 'CR' before displaying the next lines. To abandon the display press SPACE BAR and you will be returned to the menu.

READ:- reads into memory the contents of an Eprom currently in the programming socket. Requires a parameter range.

VERIFY:- verifies that the Eprom holds the same code as the object code in memory at the current base address. If not, the code in both the Eprom and the memory will be displayed. Like the errors reported in the Test mode, this will be shown fourteen lines at a time, 'CR' will show the next screen full and the SPACE BAR will return you to the menu. Successful verification will produce the message, 'EPROM VERIFIED OK'. Requires a parameter range.

FAST PROG.:- invokes the fast programming mode for Eproms of 8k and larger. With a smaller Eprom currently in the programming socket, it will automatically default to the slow mode to avoid damage. After successful programming there is an automatic verify of the whole range programmed, indicated by the message 'EPROM PROGRAMMED, VERIFYING', which gives way to the 'EPROM VERIFIED OK' report on completion. Lights red LED. Requires a parameter range.

SLOW PROG.:- the mode for programming Eproms smaller than 8K. With an Eprom of 8K or larger, selection of this mode allows programming in the standard way. This allows a certain degree of flexibility, since you can program Eproms of uncertain size with a tried and tested method. The messages used are the same as for the Fast mode. Lights red LED. Requires a parameter range.

DUMP:- gives a hex dump to the screen and printer in the following format: the absolute address in memory followed by the relative address from the start of the dump, then sixteen hex bytes of data and finally a two byte check sum computed from the previous sixteen data bytes. To get printer output, enter the command and parameters then press CTRL-P before the carriage return. Don't forget to turn off printer control afterwards, with another CTRL-P, or the program will appear to 'hang' for 10 seconds, whilst the print output routine times out. Requires a parameter range.

NEW TYPE:- the command to change the type of Eprom you are working with.

BASE:- the means of changing the start address in the memory to that of any new object code.

Way Out

A common feature of all the commands that require parameters, is that the command sequence can be aborted at any time before pressing carriage return by use of the SPACE BAR.

Without using the 'QUIT' command, the program can be left by pressing either the 'ESC' key or the 'RESET' button. Neither is recommended, since they both interrupt commands at indeterminate points. The 'ESC' key is particularly bad as it will leave the programming socket with power and signals present. If 'RESET' is used it will be necessary to restart the programmer software via the cold start vector. The reset is also issued to the PIO's, setting the ports to a safe state. They will then need to be re-initialised before they can be used again. It should be obvious when the socket is unsafe, because the green LED will not be lit.

The best method of exit is the 'QUIT' command which can only be issued when the programmer is in a safe state and which allows faster re-entry via the warm start vector at E803h.

If you should chance to use 'ESC' or 'RESET', re-entry to the program will re-initialise the PIO ports and set the socket to a safe state.

Waveform Diagrams

The outputs of the programmer hardware during fast programming change rapidly compared to those resulting from the 50ms pulses of the slow programming mode.

Figures 3, 4 and 5 show the programming voltage VPP, the supply voltage VCC and the actual program pulse, NPGM (Not PGM), as they appear on a oscilloscope for a number of different Eproms in fast mode.

Figure 3 shows the waveforms for the 2764 and 27128. The 2764A and 27128A are the same, except that VPP is only 12.5 volts.

Figure 4 is the diagram for the 27256 and shows the effect of having chip enable (CE) on the same pin as the programming pulse.

Figure 5 shows the waveforms for the 27512, in which output enable is on the same pin as the programming voltage, and as with the 27256, CE and PGM share a pin.

Future Developments

The author's system includes a TUG Eprom Storage Card (ECS) and he is currently developing a 4K software package with enhanced error checking and additional routines for use with this. Features planned include support for other devices, new utilities, such as memory fill and relocation, and access to programs on the ESC and disc.

Currently being developed is a hardware interface to connect the programmer to a BBC Microcomputer and a sideways rom to allow its use. The hardware has actually been finished and tested. The sideways rom is in mid development. *(Keep watching ETI — Ed.)*.

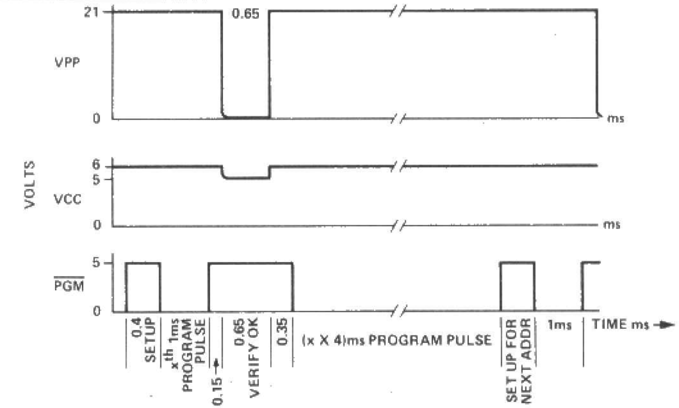


Fig. 3 Timing diagrams for 2764/27128.

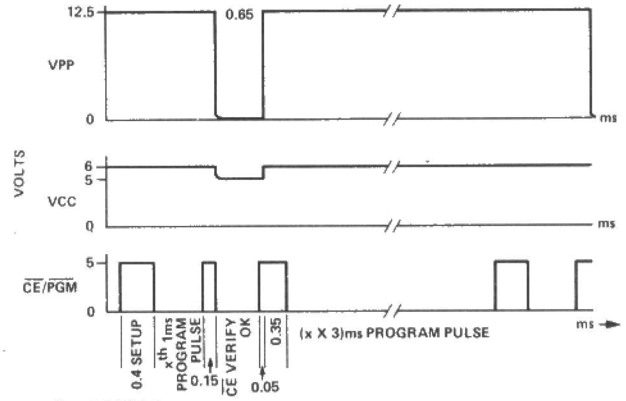


Fig. 4 Timing diagrams for 27256.

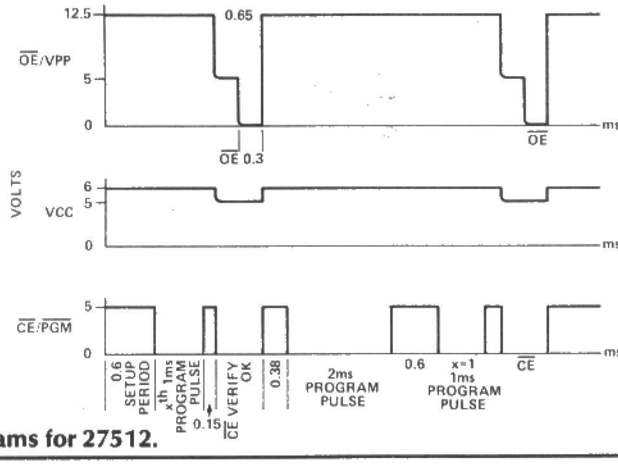


Fig. 5 Timing diagrams for 27512.

HOW IT WORKS

On entry through the cold start the PIOs are initialised to the correct inputs and outputs and then zeroed to a safe state. The header message is displayed and the type of Eprom to be operated on is requested along with the base address in memory where the object code resides. Then the help menu is displayed and the software waits for an input.

The program runs a background loop (GETCMD) waiting for characters typed at the keyboard. When an input is received the character is checked against a list of valid commands. On finding one, a jump is made to the corresponding subroutine, otherwise the program simply returns to the background loop.

Entry through the warm start vector does not initialise the PIOs or ask for Eprom type and address, as these are assumed. Instead, the menu is displayed and control passes directly into the background loop. This is intended for a quick return to the program after using the Tanbug monitor facilities. If a program has been run, such as a two pass assembler, which might have corrupted zero page locations used by the Eprom programmer software, it would be wise to return through the cold start vector.

Immediately after the two vectors (at E800h and E803h) in the Eprom there are the tables used for setting up the PIO ports in the configurations required for the functions and Eproms supported. To add other Eprom types to the software these tables would have to be extended and further entries made in the type and length parameters stored from E861h and E8C9h. This is not easy without a full disassembled listing and the use of a two pass assembler. There is no further space available in the current Eprom, so something would have to be removed, which should be no great problem as all subroutines are modular.

The screen clear routine (CLRSCN) is only called twice, from the header at E9CF h and by the help routine at EA23 h. It will not work with 80 column boards. It is the last subroutine in the Eprom at EFEC h.

BUYLINES

For those not wishing to type in the code from the hex dump, a ready programmed Eprom complete with assembler listing is available for £10.00, from G. J. Bennett, 35 Fowler Road, Cove, Farnborough, Hants. Alternatively, the source code (for use with the TUG two pass assembler/editor) and object code on tape are available for £5.00 from the same address. Please allow 28 days for delivery.

The hex dump and full disassembled listing will appear in ETI next month.

TECH TIPS

Frequency Fine Tuning for ETI Distortion Meter

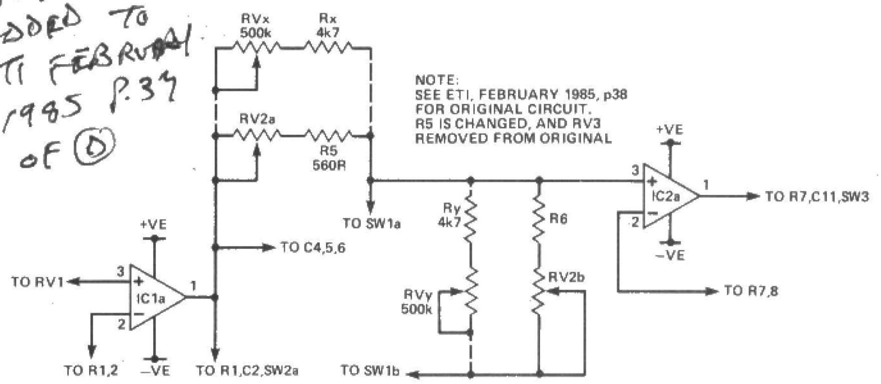
Walter Wirth
Sri Lanka

In the text of his Distortion Meter project (ETI, February 1985), John Linsley Hood bemoans the lack of low resistance dual gang pots for fine tuning the frequency of the notch filter. However, high resistance dual pots are available. Instead of using a low value dual pot, the same result can be obtained by using a high value dual pot in parallel.

The diagram shows the relevant circuitry from the original design with the additional components attached by dashed lines. A 500k linear dual pot (designated RVa, b) in series with 4k7 resistors (to prevent too low a minimum resistance) is wired across notch frequency control RV2a, b and associated resistors R5 and R6.

Note that R5 and R6 are given the same value of 560R. RV3 in the original circuit is deleted being replaced by the 500k dual pot which will give the necessary non-interactive fine tuning capability mentioned in the original article.

NOTE ADDED TO ETI FEBRUARY 1985 P.37 OF ⓓ



NOTE:
SEE ETI, FEBRUARY 1985, p38 FOR ORIGINAL CIRCUIT.
R5 IS CHANGED, AND RV3 REMOVED FROM ORIGINAL

Pulse Group Generator

Paul Cuthbertson
Inverurie
Aberdeen

The idea for this circuit arose when I needed to modulate a transmitter with a burst of 1kHz about 100mS long every second. The circuit costs less than a pound and has the following advantages:

a) less complex than the usual two 555s in series;

b) low power consumption at about 800μA (not including output stage);

c) guaranteed known number of pulses in each group or burst, all the same width (no glitches due to non synchronised gating);

d) extremely flexible, with pulse grouping depending only on diode configuration. (The only restriction on this is that each burst or burst of bursts contains 2^n pulses where n is a whole number between 1 and 12);

e) duty cycles and pulse arrangements do not vary with frequency;

f) frequency is easily varied by altering the resistors on pin 10 or by chopping an existing pulse train injected at pin 11;

g) maximum attainable frequency typically 8MHz, minimum operating voltage theoretically 1V, but not at the same time!

The circuit works by dividing the square wave on pin 9. Various counter outputs are available to do the gating. In the example shown, only when 8, 9 and 10 are all high will pulses be output. R1, R2 and C1 set the operating frequency using the 4060's internal clock circuitry. R3 prevents the O outputs conflicting with pin 9. There are residual pulses remaining when the O outputs are low, and R4 and R5 form a divider which prevents the output transistor, Q1, turning on with these 0.7V pulses. (A foward-biased diode in the base of the transistor often serves the same purpose.)

On a more speculative note:

a) use the 4040 or 4020 'sister chips' (ouch, that Hertz!) which have different sets of outputs available (but no built-in clock circuitry);

b) turn the diodes round (all of them, note) to get a 'disabled high' with different patterns;

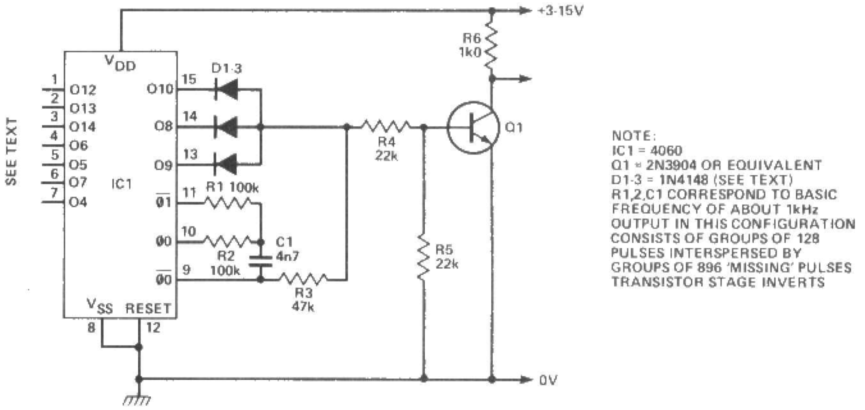
c) some of these chips have Schmitt inputs - inject a sine wave;

d) use another transistor to invert a set of diode outputs, summing the result of this back into the system to get bursts of pulses other than 2^n in number;

e) feed one of the Qs back to reset input;

f) use a series of changeover/centre off switches to switch diodes out of circuit, or to an inverter or the normal matrix;

g) use the gate signal itself as an output giving precise control over duty cycle at varying frequencies of input.



NOTE:
IC1 = 4060
Q1 = 2N3904 OR EQUIVALENT
D1-3 = 1N4148 (SEE TEXT)
R1,2,C1 CORRESPOND TO BASIC FREQUENCY OF ABOUT 1kHz
OUTPUT IN THIS CONFIGURATION CONSISTS OF GROUPS OF 128 PULSES INTERSPERSED BY GROUPS OF 896 'MISSING' PULSES
TRANSISTOR STAGE INVERTS

Simple CMOS Frequency-Window Discriminator

Thomas Schaerer
Switzerland

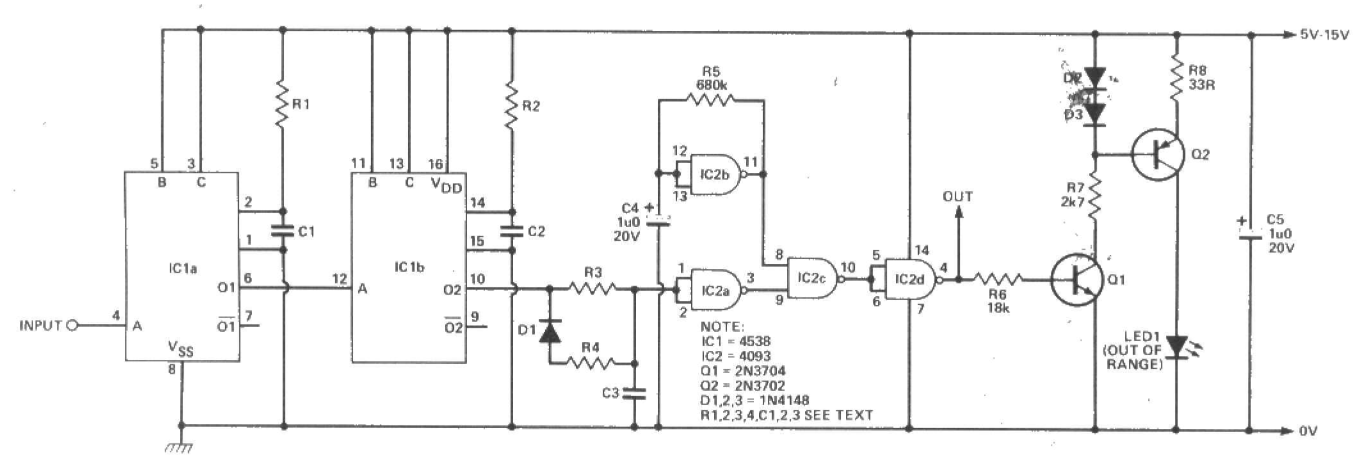
If you have to convert any environmental signal (temperature, pressure or humidity, for example) using a voltage-to-frequency converter, and you have to pay attention to an allowed range of signal values, then you should use the following very simple circuit. The circuitry consists of two CMOS ICs, two transistors and associated passive components. It requires a clean pulse wave input, so if your signal is noisy or irregular you should add a Schmitt-trigger stage at the front end of the circuit. The supply voltage can be between +5V and +15V — although this will affect the precise pulse widths involved, which should therefore be independently measured for accurate calibration. With a low Vcc, R4 can be as low as 470R. If Vcc is 15V, however, R4 should be a minimum of 1k5.

IC1 is a dual, retriggerable monostable.

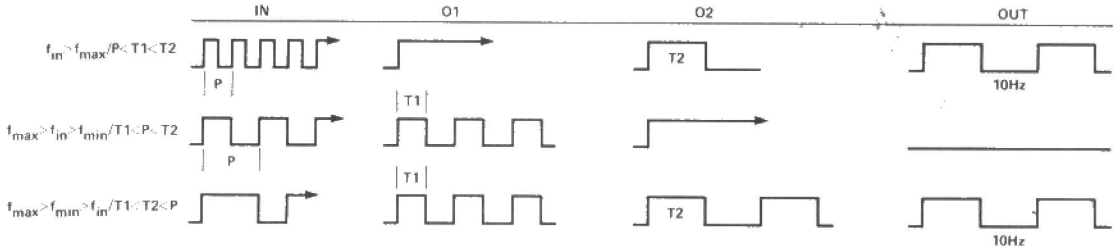
IC1a detects the input frequency. A positive-going input pulse will trigger an output pulse of width given by R1xC1. If another pulse appears on the input before the output pulse finishes, the output will be retriggered. So, if the frequency of the input exceeds a given limit, fmax (equal to 1/R1xC1), the output on pin 6 will be high for the duration of the input signal (and for a short time thereafter until IC1a resets itself). The signal on pin 12 (the input of IC1b) will therefore go high and stay there, so that the output on pin 10 will be a single pulse of width given by the time constant R2xC2.

If the frequency of the input is below the limit fmax, the output on pin 6 will be a pulse wave of frequency equal to the input but of pulse width equal to R1xC1. Now, if this frequency is higher than fmin (equal to 1/R2xC2) the output of IC1b will be continuously retriggered giving a high on pin 10 for the duration of the input signal (and for a short time thereafter until IC1b resets itself). If the frequency is lower than fmin, the output of IC1b will be a pulse wave of frequency equal to the input but of pulse width equal to R2xC2.

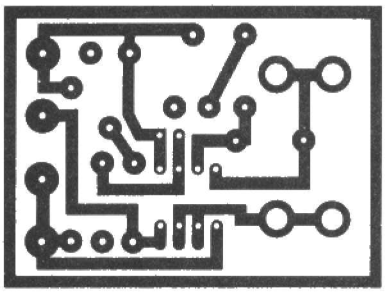
In short, an input frequency *above* fmax will result in a single pulse of width R2xC2 on pin 10 of IC1; an input frequency *below* fmin will result in a train of R2xC2 pulses on pin 10; and an input frequency *between* fmax and fmin will result in a high level output on pin 10. The RC network on pin 10 should have component values which ensure that R2xC2 pulses do not reach logic high on the input to IC2a, a Schmitt-triggered NAND gate wired as an inverter. R3 and C3 should have a time constant at least three times greater than R2xC2. R4 should be considerably lower than R3 (between 470R and 1K5R, depending on Vcc). Along with the steering diode, D1, R4 ensures a rapid discharge of C3, while R3 is designed to charge it slowly. With suitable values, pin 1 and 2 of IC2 will be low except when the input signal frequency lies between fmax and fmin. This low will enable IC2c,d to transmit a 10Hz signal provided by the simple oscillator formed by IC2b, R5 and C4. This signal is directly available on pin 4 of IC2 and is also fed to the LED via a constant current source comprising transistors Q1 and Q2 and associated components. The constant current source ensures that LED brightness does not vary with supply voltage. It should be noted that R1 and R2 must both be greater than 5K, although there is no limit on C1 and C2. The maximum input frequency in this circuit can be in excess of 100kHz, although the accuracy of the circuit at this end of the range and even more so, at the low end of the range when using large-value electrolytics, may be uncertain. For adjustment of ranges and calibration, it would be possible to replace R1 and R2 by suitable pots in series with fixed resistors of 5k or more.



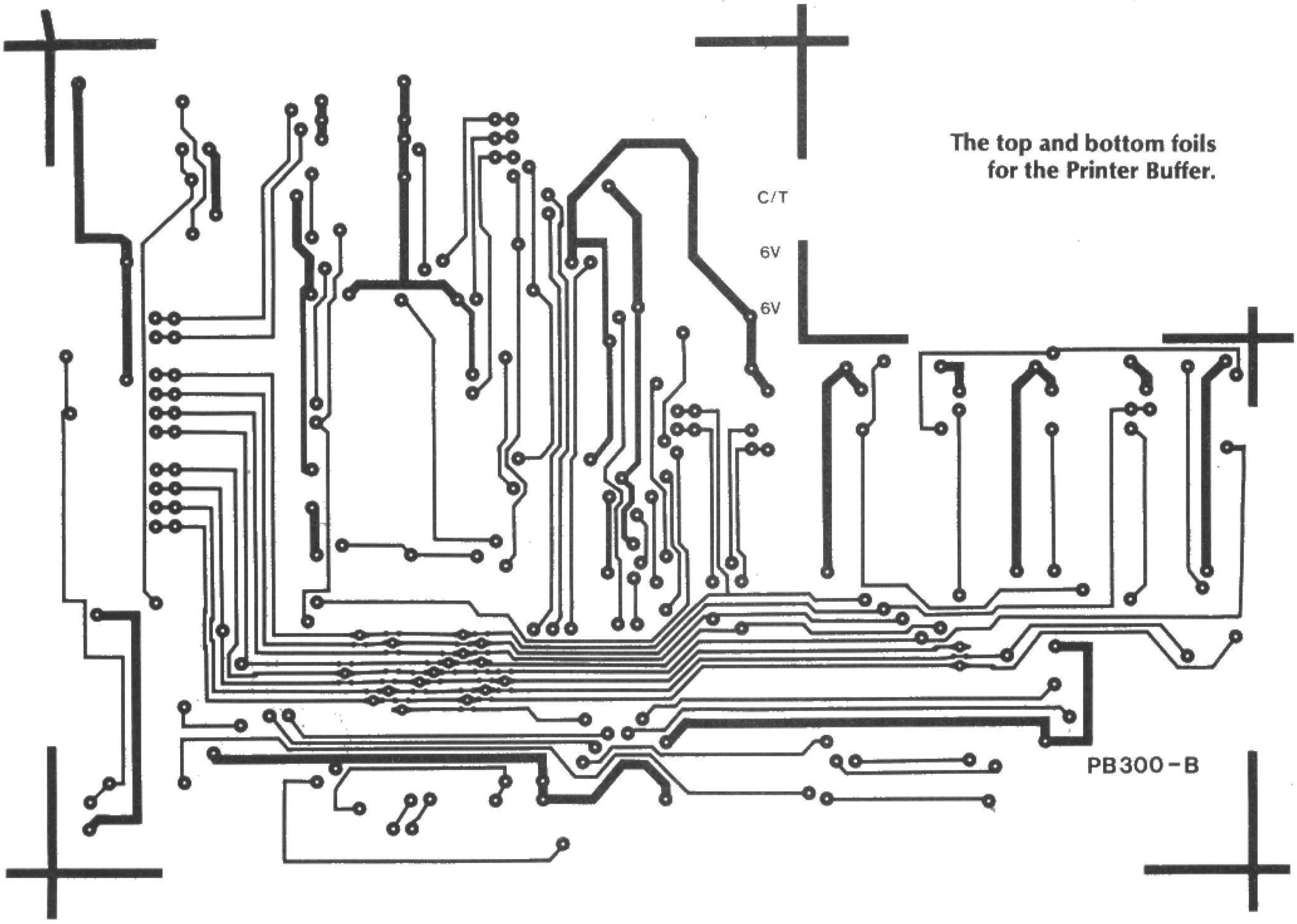
NOTE:
IC1 = 4538
IC2 = 4093
Q1 = 2N3704
Q2 = 2N3702
D1,2,3 = 1N4148
R1,2,3,4,C1,2,3 SEE TEXT


IN
O1
O2
OUT
$f_{in} > f_{max}$/P < T1 < T2
$f_{max} > f_{in} > f_{min}$/T1 < P < T2
$f_{max} > f_{min} > f_{in}$/T1 < T2 < P
P
T1
T2
10Hz

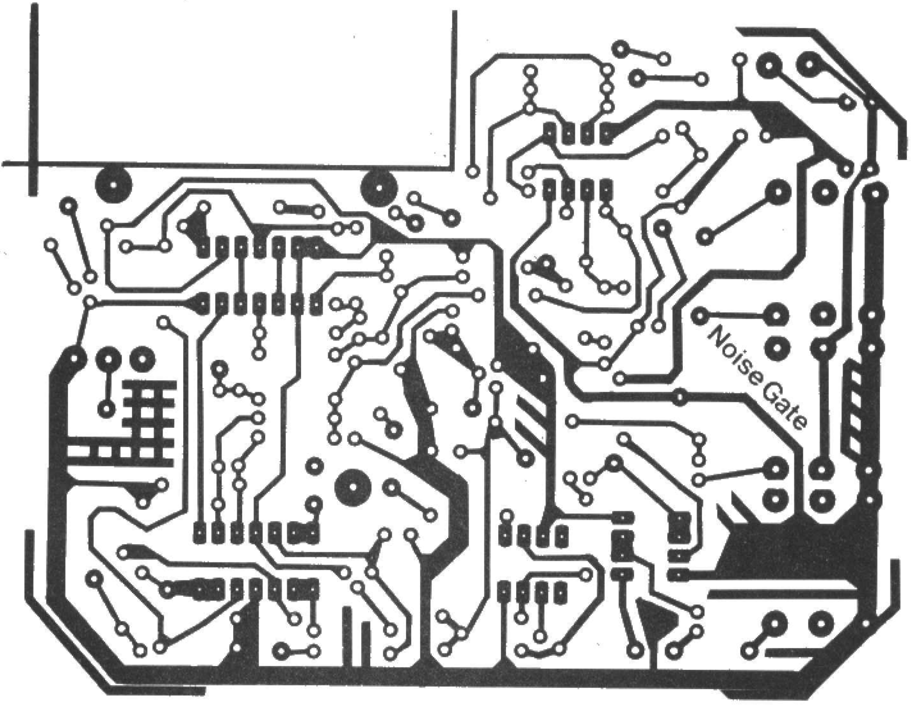
PCB FOIL PATTERNS



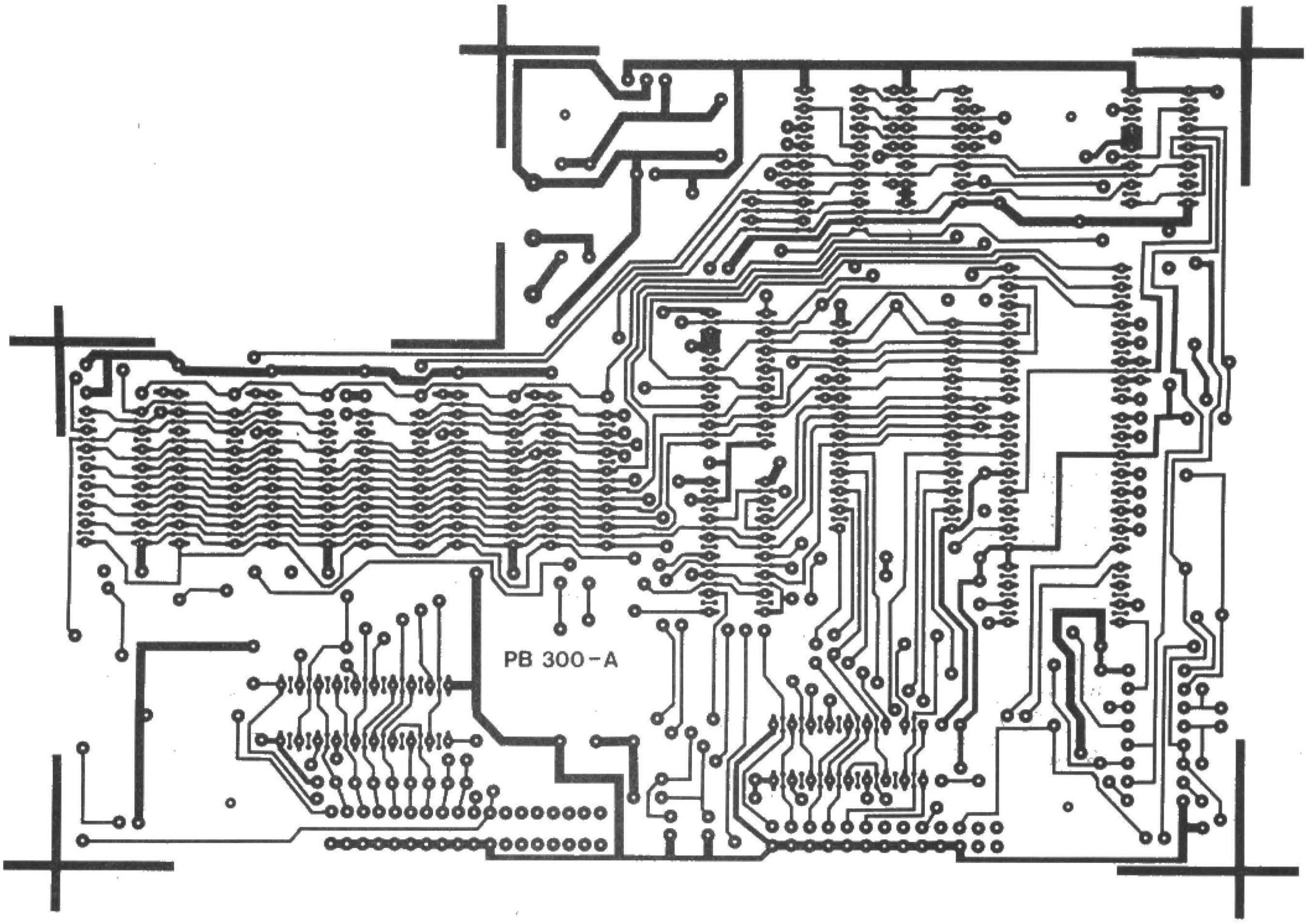
The foil pattern for the Heat Pen, held over from last month.



The top and bottom foils
for the Printer Buffer.



The foil pattern for the Noise Gate PCB.



ETI PCB SERVICE

In order to ensure that you get the correct board, you must quote the reference code when ordering. The code can also be used to identify the year and month in which a particular project appeared: the first two numbers are the year, the third and fourth are the month and the number after the hyphen indicates the particular project.

Note that these are all the boards that are available — if it isn't listed, we don't have it.

Our terms are strictly cash with order — we do not accept official orders. However, we can provide a pro-forma invoice for you to raise a cheque against, but we must stress that the goods will not be dispatched until after we receive payment.

1981
☐ E/8106-8 Waa-Phase............ 1.76
☐ E/8106-9 Alien Attack............ 4.00
☐ E/8107-1 System A-Input (MM/MC) .. 3.05
☐ E/8107-2 System A — Preamp 5.95
☐ E/8107-3 Smart Battery Charger ... 2.27
☐ E/8108-5 Watchdog Home
Security (2 boards) 6.11
☐ E/8109-1 Mains Audio Link (3 bds) ... 8.45
☐ E/8109-4 Laboratory PSU 5.21
☐ E/8110-1 Enlarger Timer........... 3.91
☐ E/8110-2 Sound Bender........... 3.05
☐ E/8111-1 Voice Over Unit......... 4.57
☐ E/8111-3 Phone Bell Shifter........ 3.40
☐ E/8112-4 Component Tester....... 1.71
1982
☐ E/8202-2 Allez Cat Pest Repeller ... 1.93
☐ E/8202-5 Moving Magnet Stage.... 4.01
☐ E/8202-6 Moving Coil Stage 4.01
☐ E/8203-4 Capacitance Meter(2bds) 11.66
☐ E/8205-1 DV Meg 3.13
☐ E/8206-1 Ion Generator (3 bds) 9.20
☐ E/8206-4 MOSFET Amp Module ... 7.80
☐ E/8206-5 Logic Lock............... 3.52
☐ E/8206-6 Digital PWM............ 3.84
☐ E/8206-9 Oscilloscope (4 bds).... 13.34
☐ E/8212-2 Servo Interface (2 bds) ... 6.75
☐ E/8212-4 Spectracolumn.......... 5.54

1983
☐ E/8301-1 Fuel Gauge.............. 3.45
☐ E/8301-2 ZX ADC................... 2.59
☐ E/8301-3 Programmable PSU...... 3.45
☐ E/8303-1 SoundBoard 12.83
☐ E/8303-2 Alarm Module........... 3.62
☐ E/8303-3 ZX81 User Graphics 1.07
☐ E/8303-4 Logic Probe............. 2.50
☐ E/8304-1 Real Time Clock......... 8.74
☐ E/8304-4 Stage Lighting — Main ... 13.73
☐ E/8304-5 Stage Lighting — Display 3.45
☐ E/8305-1 Compressor/Limiter 6.19
☐ E/8305-2 Single PSU............. 3.16
☐ E/8305-3 Dual PSU 4.01
☐ E/8305-4.2 NDFL Amp 7.88
☐ E/8305-5 Balance Input Preamp.... 3.23
☐ E/8305-6 Stage Lighting Autofade .. 6.19
☐ E/8305-7 Stage Lighting – Triac bd . 4.74
☐ E/8306-1 to 3 Pseudo ROM (3bds) . 3.62
☐ E/8306-5 Atom Keypad........... 5.18
☐ E/8307-1 Flash Sequencer......... 2.67
☐ E/8307-2 Trigger Unit Main Board... 2.67
☐ E/8307-3 Trigger Unit Transmitter 1.66
☐ E/8307-4 Switched Mode PSU.... 16.10
☐ E/8308-1 Graphic Equalisr......... 9.10
☐ E/8308-2 Servo Fail-Safe (4 off) 2.93
☐ E/8308-3 Universal EPROM prog ... 9.64
☐ E/8309-1 NiCad Charger/Regen ... 3.77
☐ E/8309-2 Digger................... 3.40
☐ E/8309-3 64K DRAM 14.08
☐ E/8310-1 Supply Protector 2.19
☐ E/8310-2 Car Alarm............... 3.98
☐ E/8310-3 Typewriter Interface 4.17
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REVIEWS

528T Multitester

Hardware

Semiconductor Supplies
International Ltd.
Dawson House
128/130 Carshalton Road
Sutton
Surrey SM1 4RS

price: £31 plus VAT

DM30 Multitester

Hardware

Selectronix
Tower House
Lower Kings Road
Berkhamstead
Herts HP4 2AB

price: £39 plus VAT

There seems to be a smallish flood of low price digital multimeters incorporating transistor testers coming to the market right now. The two reviewed here are typical of most cheaper DMMs. The inclusion of the transistor test facility, however, makes them definitely attractive to the home constructor.

Understandably, there is a certain amount of resistance to the idea of using DMMs. As with digital watches, the display is nowhere near as immediate as the scale on an analogue meter. Personally, I find the lack of a calibration feature also annoying — I can never quite trust the reading I get, even though the accuracy is clearly high and the DMM circuitry undeniably reliable.

The manufacturers of the DM30 claim an accuracy of 0.5% on the DC voltage scales, while the 528T's manufacturers claim 0.8% on the same scales. There was a distinct difference in their readings under test, although in both cases the accuracy was clearly better than 1% and the differences were barely significant. In that respect these meters were both undeniably useful instruments, despite my prejudices.

Both meters originate in Taiwan, the DM30 coming via a Swedish distributor. The 528T, although cheaper, is the most attractive of the two and includes an integral stand, an idiot proof socket for transistors under test and standard ¾ inch probe sockets. Unfortunately, it only boasts 14 ranges (including the H_{FE} measurements scale for testing transistors).

Both meters incorporate readable 3½ character, ½ inch LCD displays, but the DM30 has 29 ranges (if you include NPN and PNP transistor testers, a battery tester, a diode tester and continuity buzzer setting). The DM30 allows AC current measurement and a wider range of AC voltage measurement than the 528T. There is a 10A DC current range, too. It also gives an indication of a low battery condition when the meter's internal PP3 battery runs down to less than 1 V.

Major disadvantages of the DM30 are the price (£46.57 including VAT and post and packing), the somewhat confusing and non-standard probe sockets and the rotary range setter which could lead to problems with NPN and PNP transistors being tested for H_{FE} and with AC and DC ranges. The meter does seem to be well-protected, but this leads me to one other problem with the DM30.

In the course of reaching these shores, it seems to have acquired the title 'DM30' from nowhere. The manual makes no reference to this model, recognising only a 105, a 208 and a 305 version of the meter. It doesn't take a great deal of detection to work out that the DM30 is acutally the 305 version (where are the other two?), but the need for *any* detection doesn't exactly inspire confidence in what is otherwise a comparatively full and useful guide (including somewhat confusing but potentially valuable circuit diagrams).

That said, the choice between the two meters comes down to this: the 528T is the winner ergonomically and in terms of style; while the DM30 is undoubtably the more versatile. Unless you're desperately counting your pennies (in which case, I'd recommend a cheap analogue meter), the DM30 is probably the better buy. Although it couldn't, for example, be used with ETI's Heat Pen (unless you take the 10A socket to be at earth potential, since otherwise common and voltage sockets are not spaced at ¾ inch), it incorporates all the voltage, current and resistance ranges you're ever likely to need. I think that's worth an extra £10 or so.

Gary Herman

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REVIEWS

MICRO PROFESSOR MPF-I/88

Hardware

Flight Electronics
Flight House
Quayside Road
Blitterne Manor
Southampton
Hampshire SO2 4AD

price: £325 plus VAT

With so many cheap microcomputers around, it's a legitimate and often asked question as to why anyone should want to pay well over the odds for an evaluation/development system — little more than a microprocessor, some operating system ROM and a few K's worth of RAM. The system under review, for example, contains one 27128 ROM and two 6116 static RAMs along with the 8088 mpu and associated bits and pieces. That's 20K of memory for a price of £300 odd — not, at first sight, a bargain.

Of course, the MPF-I/88 — like its Z80-based predecessor, the MPF1-P is not intended to be direct competition for a microcomputer — home, office or otherwise — and that's where the answer to the question comes in. The system is a development tool, to be sure, but its major use will undoubtably be as an educational aid. To understand its appeal and to evaluate its worth, then, it's important to bear in mind where the MPF-I/88 will end up: not in a bedroom plugged into a spare television set, nor on the desk of a busy secretary or tired executive, but on workshop benches in colleges, ITeCs and even, perhaps, schools.

The original Microprofessor MPF1-P was notable for a number of features. It was a single board system sold in a largish book-style plastic binder. Based on the Z80, it included a small rubbery, keyboard and a four character LED display, by means of which the programmer could directly access, read and alter the contents of memory. The firmware included a fairly basic machine code monitor and a very basic BASIC (which was practically unusable and which has, thankfully been dropped from the MPF1/88). What was exceptional about the Microprofessor was the documentation. Despite occasional lapses into Taiwanese English (the MPF1-P and the MPF1/88 are both produced in Taiwan by the Multitech Industrial Corporation), the manuals were a model of clarity and comprehensiveness.

The importance of documentation in the microprocessor field cannot be overstated. There are really two reasons why an ordinary micro is not of much use when it comes to learning about MPUs: the first is the typical lack of monitor or assembler facilities (often combined with the complexity of system firmware which makes it difficult to get to grips with the heart of the machine); the second-most crucial-is the abysmally low standard of documentation for micros, especially on the hardware and system firmware level. The MPF1-P overcame both of these problems by offering a simple monitor with useful input-output devices and documentation which was — relatively speaking — a joy to use.

With the MPF-I/88, Multitech and their UK agents (Flight Electronics) have moved on to higher ground. The 8088 is clearly a compromise MPU, but an effective and a welcome one. The device is equivalent, from the user's point-of-view, to the Intel 8086 which is the industry standard 16-bit processor. The 8088 is, in fact, used in the IBM PC, while the 8086 can be found in the majority of true 16-bit machines.

The differences between the 8088 and the 8086 are subtle but significant. The '8 uses an 8-bit data bus, allowing for downward compatability with much hardware developed for the 8080 and Z80 MPUS, while the '6 uses a 16-bit data bus with the advantage of increased execution times. From a software point-of-view, both processors are identical — the '8 being designed to fetch or write 16 bits in two consecutive bus cycles, while the '6 performs the same operation in only one cycle. Both devices can also directly address up to 1 M byte of memory by means of a 20-bit address bus.

The MPF-I/88 makes good use of the 8088. On the one hand, it is compatible with many IBM add-on cards and can also read and write data in IBM tape format. On the other hand, a fairly simple modification enables many Z80 boards devised for the original Microprofessor to be used. In fact, Flight are supplying an interface which accepts up to three IBM-style cards and also reconfigures the bus to accept Z80 peripherals: an EPROM programmer, printer, sound generator and speech synthesizer. IBM-style cards available from Flight include an RS232c interface and a video board.

The basic system is attractive even without these add-ons. Unlike the original Microprofessor, the MPF-I/88 is properly cased and includes a full QWERTY keyboard (of adequate quality). The visual display has also been improved, by use of a two line by 20 character LCD screen. There are actually 24 'logical' screen lines which can be scrolled by use of the 'ALT' key on the keyboard.

The board itself is easily accessible and you can get to the two spare ROM sockets and the one spare RAM socket. Each of the three ROM sockets can take 8K or 16K ROMs while the RAM sockets can take 2K or 8K chips. Also accessible is the expansion bus — 2x31 hole rows arranged to take an H-connector and taken out to a 64-pin card-edge connector at the back of the machine. On the back, there is also a Centronics compatible printer port, tape in and out sockets and the PSU socket.

The upgraded features like the keyboard and the LCD display have been made available, I'm sure, because of the added complexity of the 8088. The MPF-I/88 incorporates a machine-code monitor and what the manufacturers describe as a 'line assembler', which is a straightforward and fairly comprehensive assembler/disassembler. The assembler, in particular, is easy to use and powerful — the more so because the operating system includes a number of subroutines called by using the 8088 software interrupt.

As a relative newcomer to 8086/8088 operations, I have to say that they are both lucid and powerful. It is worth considering getting hold of an MPF-I/88 to teach yourself 8088/8086 code, if only because these chips are so well thought out.

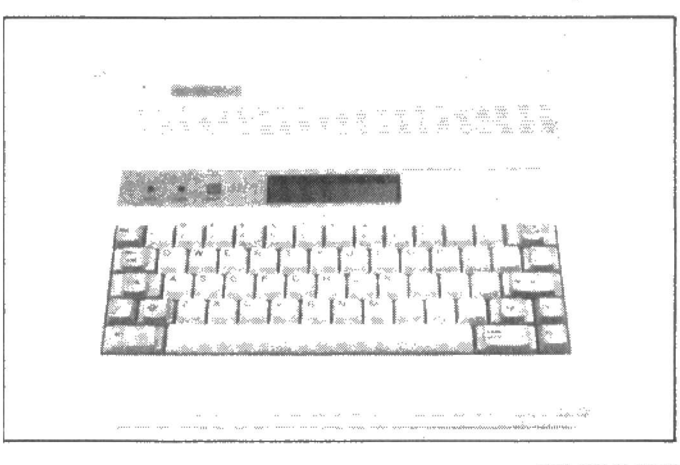
The documentation was only slightly disappointing. Regrettably, it is provided in three booklets — the User Manual, the Reference Manual and the Monitor Program Listing — and this means you may find yourself chasing a piece of information across acres of paper. The situation is worsened by the lack of any sort of index.

All the necessary information is available, if you're prepared to look for it, and the standard of the translation has actually improved since the days of the MPF1-P. All the same, I found it annoying to have to turn to the user manual for the 8088 pin-outs and instruction set when the reference manual contains circuit diagrams and an appendix entitled 'Introduction to 8088 Assembly Language'. Logical presentation is not a strong point.

In one other respect the MPFI/88 documentation is less adequate than that provided with its predecessor. The earlier system manuals came complete with a useful number of well-explained model programs. There is no better way of learning programming languages — high or low level — than by entering someone else's program and seeing how it works. Unfortunately, the MPF-I/88 documentation pays scant attention to this aspect of the learning process.

A more general question remains. Why spend time and money learning about 16-bit or pseudo 16-bit microprocessors when we have far from exploited all the possibilities of the familiar 8-bits? There really is no adequate answer to that, except to invoke the virtues of knowledge for its own sake and, by the way, to say again that the 8088/8086 are more powerful and, in some ways, more logically designed MPUs than the best-known of the 8-bits. If you're starting out with microprocessors, I'd seriously suggest you consider starting out with an 8088. If you're an old hand, well the 8088 should come easy. In either case, the MPF-I/88 will give you every oportunity to learn what the thing can do and to do a great deal of it.

Gary Herman



OPEN CHANNEL

It appears there is more to this satellite TV thing than first meets the eye. I reported, last month, the position of the Club of 21 (the consortium which is to operate Britain's DBS television services), which does not feel inclined to accept the deal arranged by satellite supplier, Unisat. The price for Unisat's satellite services, says the consortium, is much too high. They would prefer to accept tenders from other organisations first, then choose the most desirable. The Government, however, does not see the situation in the same light, apparently preferring the Unisat solution.

The Government also holds the cards within another area of the satellite TV game: that of satellite master antenna television (SMATV) systems. SMATV refers to the type of satellite reception systems which deliver a selection of television channels, in cable form to a number of users, from a single parabolic receiving aerial. It's anticipated that such systems will be used initially in hotels, council housing estates, sheltered old peoples' homes, hospitals and blocks of flats — much like existing terrestrial based community aerial television systems. It is not unreasonable to assume that individual households may also take advantage of SMATV.

And it's this last fact which is worrying not only to the existing cable television operators, but also the Club of 21 with its proposed DBS television services, because both cable *and* DBS services would be undermined if individuals sidestep them and buy their own SMATV receivers.

Channel choice

Thorn EMI is one of the biggest organisations looking to SMATV for future television services. It already owns and runs three SMATV television channels: the pop video channel *Music Box*, the film channel *Premiere* and the kiddies' *Children's channel*. Apart from operating three of the proposed six or seven SMATV channels though, Thorn EMI is also hoping to provide much of the necessary receiving equipment — parabolic aerials, converters etc — to franchises around the country. They, in turn, will lease the equipment to SMATV users. The other existing SMATV channels are: *Ten — The Movie Channel* (a direct competitor of *Premiere*), the general entertainment *Sky Channel* and *Screen Sport*. The other channel in the pipeline (or should I say in the air?) is *Cable News Network*.

You pays your money . . .

Knowing this, it's easy to see why the Club of 21 may be worried about individuals using SMATV: the programme content of the SMATV channels is of a very high entertainment level. Of the six DBS channels, on the other hand, four must be the existing BBC and IBA channels. Only two channels of DBS transmissions, therefore, are free for new entertainment channels — even if the Government allows their use for such. The Club of 21, with its legal obligation to relay four old-hat channels, must be feeling pretty down and worried about its commercial viability. Potential users of satellite television services may view the high entertainment content of SMATV channels as being worth the one-off initial outlay of SMATV receiving equipment. Particularly so bearing in mind that the four BBC and IBA channels are already receivable 'off-air', anyway, and that DBS receiving equipment is not going to be cheap.

So the Government has soon to put its cards on the table and decide how best to optimise the possible services. The decision is not easy, and becomes more difficult as time creeps by. Ideally, the decision should have been reached years ago. We might all have had improved television services *now* if it had.

Meanwhile, one of the main reasons for even considering satellite television systems over ordinary terrestrial television — that of stereo sound — appears to have been knocked down by BBC engineers.

Using a digital coding system, a stereo signal may be transmitted alongside the existing signal so that television receivers equipped with suitable decoding circuitry can provide high quality stereo sound. The system is fully compatible with existing mono television receivers and the BBC says that stereo transmissions could begin as early as 1987.

Do we really need cable or satellite television systems?

Keith Brindley

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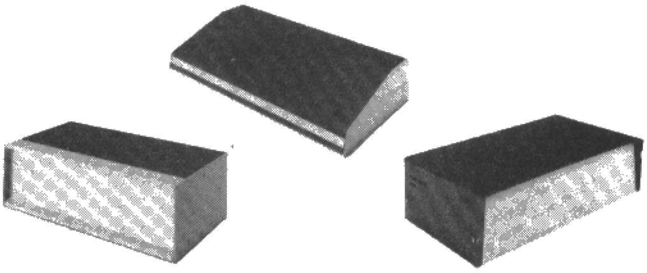

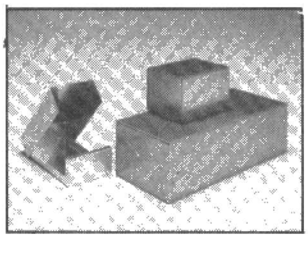

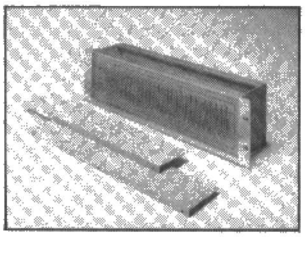

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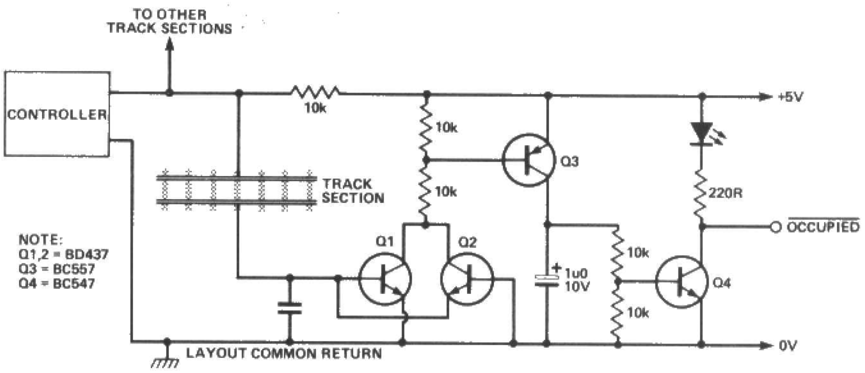
TRAINS OF THOUGHT

Typical return-rail bidirectional track circuit delivering TTL-compatible logic low when section of track is occupied.



If you have ever visited a signalbox (or tower as they call them in North America) you may well have been impressed by the mimic diagrams in which white lights indicate routes that have been set up for approaching trains; these then change automatically to red as the train enters the section of track being represented. Many railway modellers have been captivated and not a few now employ these on their own layouts.

The white lights pose few problems. The real difficulty is how to obtain reliable information as to the present whereabouts of the trains — how does the system know when to change the white lights to red?

Traditionally railway modellers have resorted to non-electronic techniques such as the use of relays. One method is to isolate a very short length of rail at the entry to a section and arrange that when train wheels bridge the gaps they complete the circuit of a latching relay. At the start of the next section a similar arrangement applies and the latching of the second relay cancels the first. Spare relay contacts abound for mimic diagrams, automatic signalling and accessory operation. All very straightforward but costly and also, by virtue of its dependence on 'dead' sections of track, it is not conducive to the smooth running of trains.

Two electronic methods of train detection are now rival claimants for the attention of railway modellers — and neither conflicts with smooth running.

Method number 1 is an electronic counterpart to the latching relay. Each section uses a bistable latch. Each latch may consist of a pair of TTL NAND gates or even, as with one layout I visited recently, pairs of BFY51 transistors with oodles of collector current capacity for mimic diagram or signal lamps. Inputs to these bistables are most often from track-mounted reed switches activated by train-borne magnets, less often from 'dead' rail lengths (as with the relay system) or from LDRs shaded by passing trains.

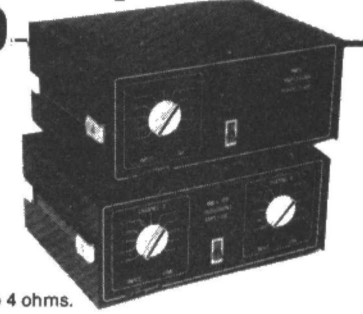
This kind of system suffers from three major shortcomings. (1) Model railways are of necessity an electrically noisy environment and unless great care is taken any bistable is likely to suffer from spurious setting and resetting. (2) At switch-on the latch may settle in the untrue state. (3) The system in its simplest form only works for one-way traffic; it can be modified for two-way traffic by doubling the number of detectors.

Method number 2 emulates the practice of track circuiting on British Rail by monitoring the electrical continuity of a section of line. Practice is to monitor the current flowing into the section from the controller (throttle) but leaving a trickle from an auxiliary supply to keep the detector going when the controller is off or at a stop. Most often the detector takes the form of a pair of small-signal NPN transistors in reverse parallel monitoring the voltage drop across a reverse parallel pair of rectifiers and transistors by using small power transistors such as the BD437 (see figure).

A fascinating aspect of this bit of circuitry is that it uses the transistor as a 'fractional-gain amplifier', since the base bias may be as high as 1A while collector current is less than 1mA! Numerous variations on this theme are in use and generally the system gives consistently accurate train detection without any problems other than a 0.7V 'diode drop' between controller and train. On my own layout the track circuit units monitor the live and return rails alternately with 'overlap zones' between sections to allow for the length of the train — since only the locomotives are detected.

This kind of reliable bidirectional train detection system with its TTL-compatible output opens the door to exciting possibilities ranging from simple TTL-based automatic signalling to mind-boggling computer-linked train control systems — of which more in later issues.

Roger Amos



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SCRATCH PAD

by Flea-Byte

I note with apprehension that video versions of the new Francis Ford Coppola megaflick, 'The Cotton Club', will be issued with an anti-piracy system built-in.

The so-called spoiler signal has long been the holy grail of the record industry - the Beatles once even paid a certain Alex Mardas a lot of money partly because he claimed to have invented a device which would prevent home taping in this way. All that 'Magic' Alex (as he was known) came up with, in the event, was a box that flashed lights in an apparently random sequence.

But now a San Jose company called Macrovision have developed a spoiler for domestic format video. Estimates of the extent of back-to-backing (that is, recording pirate videos from commercially available originals using two VCRs) suggest that it accounts for 20% of sales in the US and up to 100% of sales in some parts of the world. A spoiler would be a valuable property for its inventor.

The problem with audio spoilers is a simple one. For the system to work it must prevent you recording a listenable signal, but at some point in an audio system a clean signal must be available, whatever you do to distort or encode it during the amplification process. This may only be at the loudspeaker — but a good microphone could pick up this signal, not to mention a pair of wires attached to the speaker terminals.

Video is different, and the Macrovision system takes advantage of the differences. Apparently it works by 'confusing' the automatic gain control which is a feature of all domestic video recorders. Copies of protected tapes will then come out 'dim and noisy': not unwatchable, but only watchable with difficulty. The point is that video requires all sorts of signal processing devices to ensure reasonable quality reproduction. There is no simple electrical connection comparable to that between the output of one amplification stage and the input of the next as in an audio system.

I would guess that Macrovision have developed a technique for modulating the line sync pulse of the video signal with noise. The noise appears to be introduced at duplication stage, by means of a 'black box' between the one-inch master and each VCR slave. When played back through an ordinary VCR and television or monitor, the noise should be removed by the sync separator circuitry, without detrimental effect. On trying to record from such a noise-treated signal, however, video AGC stages (which come before sync separation) will read false signal levels. Video AGC stages usually employ a combination of keyed (or line gated) and peak detection methods. Both of these may be 'confused' by noise on the line sync pulse itself or, with the keyed method, noise on the back porch of the pulse. Suitable AGC stages are to be found in the tuner-IF stages of a TV and in the record-mode video amplification stage of a VCR — which means the noise would be effective for baseband or VHF routed signals. If my guess is correct, the result of introducing noise into the line sync pulse before it reaches an AGC should be 'dim and noisy' pictures on the tape as the record level decreases when it shouldn't and increases when it's unnecessary.

All this *is* guess work — inevitably, since Macrovision are, not surprisingly, reluctant to reveal precise information. They claim that their process maintains '100% playability and integrity of the original cassette, disk or other video source' — a claim which has not been substantiated with other, earlier, spoiler processes. They only hire out the necessary black boxes to duplicators on a royalty basis. Inventor John Ryan admits that his system could be circumvented by crafty professionals, but that it was designed primarily to prevent casual home-taping. While I'm aware that home-taping may be illegal and unethical, I'd be interested to hear ETI readers' views on the Macrovision process. After all, anti-piracy has to be better than the best pirates!

• • •

I had intended not to mention Sir Clive Sinclair this month, but I guess the habit's become to strong to resist. Amidst all the rumours of the impending collapse of Sinclair Vehicles and the recent critical performance of Sinclair Research (two companies which are *totally distinct!*), the financial press seem set on perpetuating myths. For the n-th time, I read in a recent Sunday Times that Sinclair introduced the first pocket calculator in 1972. Sometimes, he even seems to have invented it. This is odd, since I seem to remember Texas Instruments doing something of the sort in 1968, and it's rather like describing Freddie Laker as the inventor of the jet engine. Indeed, the Sunday Times goes on to comment that Sinclair 'has been described as the Freddie Laker of electronics.' Quite who made this perceptive comparison is not quite clear, but the two men do seem to have a great deal in common — their knighthoods being perhaps the least of it. The Sunday Times also claims that Sinclair introduced his matchbox radio in 1974, which doesn't square with my memory of having bought one in 1971 or thereabouts. The Observer, meanwhile, agrees with its competitor that Sir Clive is no businessman, recommending that he get out of the boardroom 'and back into the laboratory'. The great man, it appears, has 'tremendous contributions to make' in the field of micro-chip technology. I for one would be more confident that this was a well-considered proposal if plain old Clive (as he then was) hadn't once told me that he had no interest whatsoever in computers.

• • •

The fact that the Standard Ohm at the International Bureau of Standards in Paris is not all it's cracked up to be may have some disturbing implications. Evidently, recent measurements show that the Ohm is actually only worth 0.99999999851 ohms. Now, this may simply be the result of inflation — you know the sort of thing, a banner headline in the Financial Times: 'Ohm Falls Against Volt — An Electric Shock!'. But the question is, how long has it been going on? If the Standard Second is equally inaccurate, we may never know and it could be that Ohm's law is not only wrong but unenforceable. I think we should be told....

• • •

Among the mountain of press releases that I'm fortunate enough to have to wade through every day there is little in the way of light relief. I was, therefore, pleased to come across the announcement of the publication of a new 'data directory' from ERL Technical Books recently. The directory, which answers to the name 'tht', is — according to the press release — 'comprehensive', covering 'all types of thyristory and triacs.' I am driven to a conclusion that Henry Ford once very nearly reached. Thyristory is bunk....

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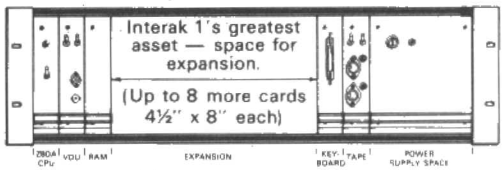
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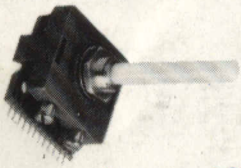

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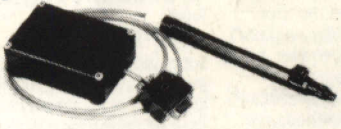

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9. (7)	◆	8W Amplifier	LW36P	£4.95	Catalogue
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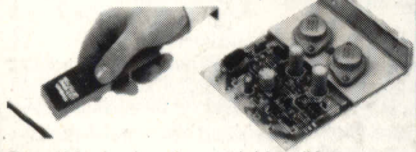

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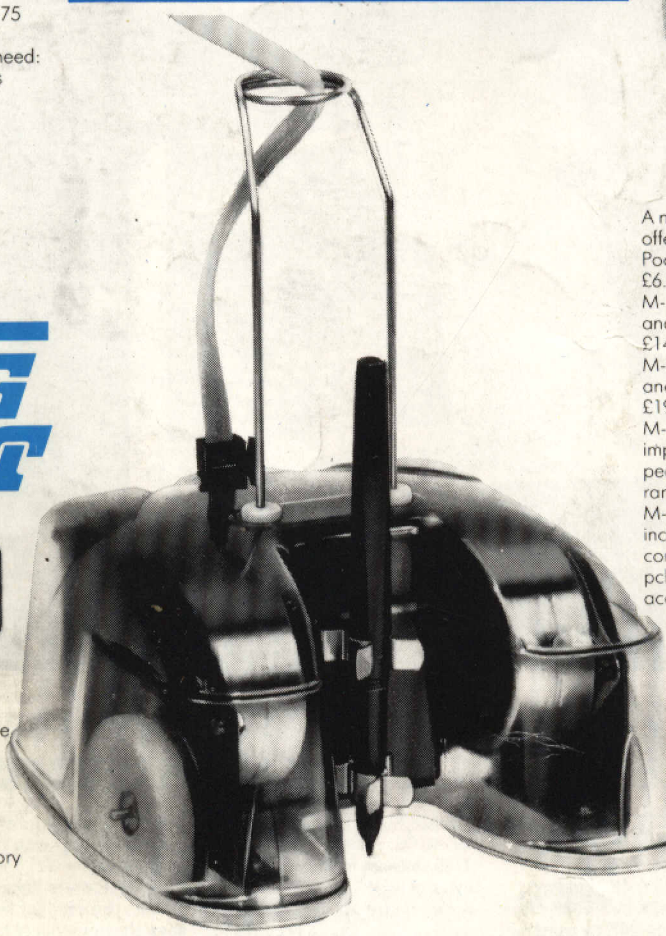

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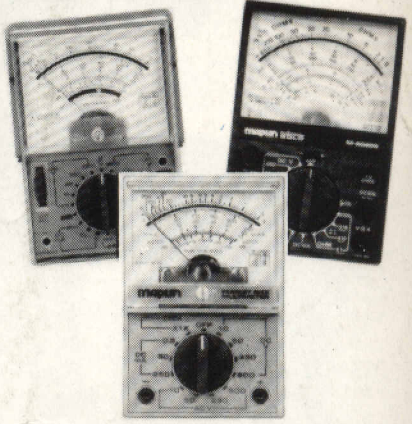

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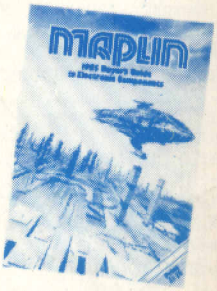

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